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USATHAMA

U.S. Army Toxic and Hazardous Materials Agency

Jefferson Proving Ground

South of the Firing Line
RI/FS Sampling Design Plan
Volume II

September 1992

Prepared for:
U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, Maryland 21010-5401

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1.0 INTRODUCTION

The purpose of this Sampling Design Plan is to provide a plan for the field sampling and laboratory analysis to be performed in support of Remedial Action/Feasibility Studies (RI/FS) at Jefferson Proving Ground (JPG), Madison, Indiana. Included in this plan are activities designed to fulfill the requirements of a Screening Site Inspection (SSI). This plan is intended to be a guide that incorporates specific rationale and objectives for each sampling and analysis activity, sampling protocols and procedures, data and document management, and data interpretation and evaluation. Also included are logistics and schedule for the proposed RI field activities.

The sections that follow describe in detail the field-investigation activities for sites identified at JPG that are known or suspected to have released hazardous contaminants to the environment and that may pose a threat to human health or the environment. As described in the Technical Plan (Volume I), several of the sites at JPG require additional information on the type(s) and extent of contaminants. This plan addresses the sampling design and procedures to be used to meet the objectives identified in the Technical Plan. Figures are included that show the proposed sampling locations, and corresponding tables are included to identify the sample number, type, and required analyses. Sections describing general equipment decontamination, sample handling, data and document management, logistics, and schedule follow the discussions of individual site field activities.

Results of the field-investigation activities outlined in this document will be used in the evaluation of:

- the presence or absence and relative concentrations of reported or suspected contaminants at identified waste sites,
- the vertical and lateral extent of contamination, and
- the potential pathways for the migration of contaminants within the environment.

On the basis of these results, an assessment of risk to public health and the environment can be made and evaluation of remedial-action alternatives can be completed.

2.0 SITE BACKGROUND

This section provides an abbreviated summary of the background information presented in the Technical Plan (Volume I), which describes the location, geologic and hydrologic setting, installation history, and previous investigations.

2.1 Location

JPG occupies 55,265 acres of land along U.S. Highway 421 north of Madison, Indiana (Figure 1). The facility is located in portions of three counties (Ripley, Jennings, and

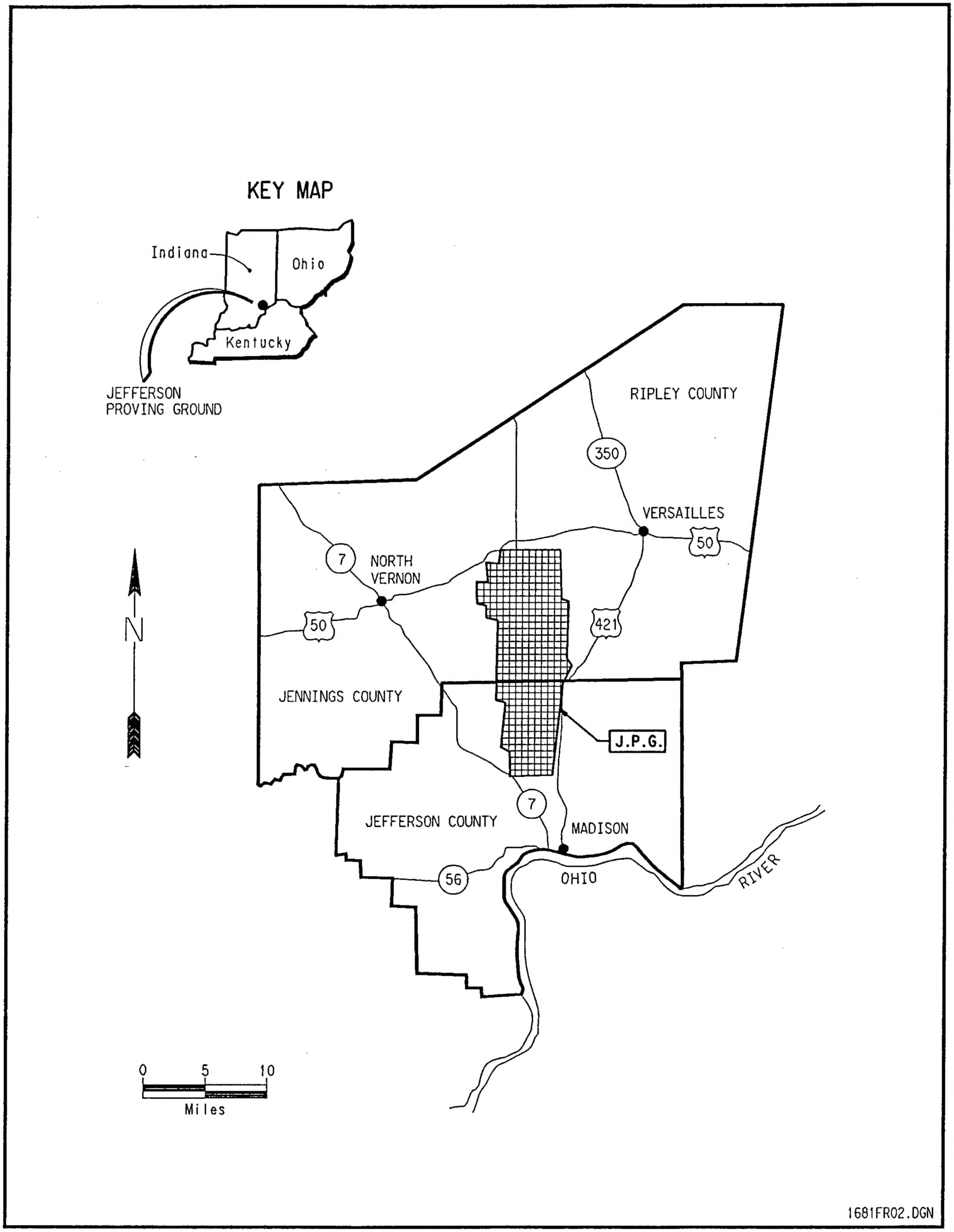


Figure 1. Location of Jefferson Proving Ground

Jefferson Counties). The installation is approximately 18 miles long (north-south) and 5 miles wide (east-west). Figure 2 shows the location of buildings, roads, and sites to be characterized south of the firing line at JPG.

2.2 Geologic and Hydrologic Setting

Jefferson Proving Ground lies on the western limb a plunging anticline known as the Cincinnati Arch. It also lies within the Till Plains Section of the Central Lowlands Province. In general, the geology at JPG is characterized by glacial till overlying Silurian and Ordovician bedrock consisting of limestones and dolomites interbedded with shales.

Unconsolidated materials consist of loess over glacial till, which are typically 25 to 35 feet thick (range from 0 to 50 feet). These deposits are generally not present in and near stream valleys. Soils at JPG have been derived from the glacial parent materials. These soils are strongly weathered, leached, and acidic. The majority of the soils at JPG are clay and silt loams with low permeability.

The soils and glacial till deposits are underlain by Silurian, Ordovician, and Devonian carbonate units. These include the Louisville Limestone, Salamonie Dolomite, and Brassfield Limestone (Silurian); Maquoketa Group, Trenton and Black River Limestones, and Knox Dolomite (Ordovician); and Muscatatuck Group (Devonian).

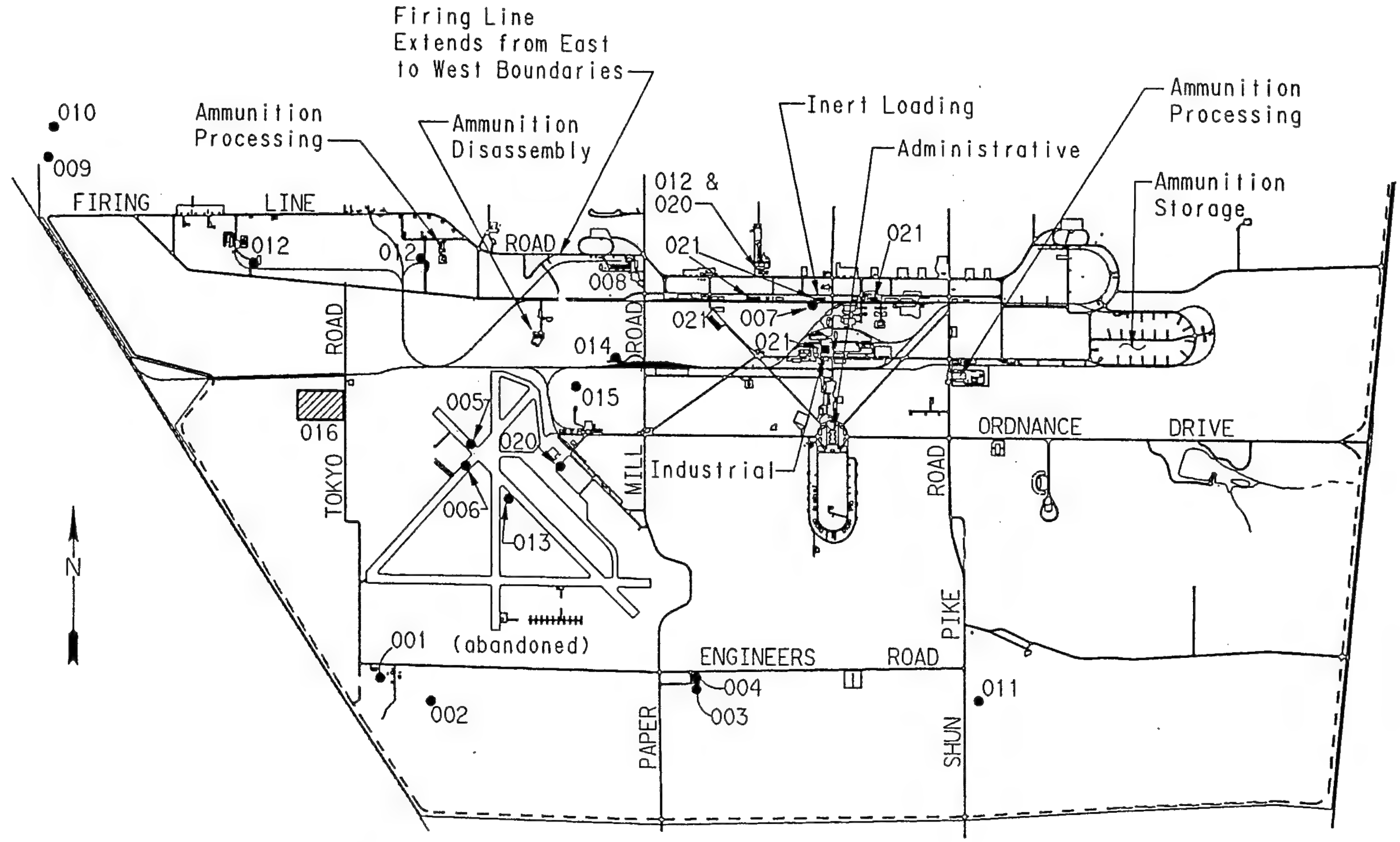
Groundwater at JPG is primarily stored in Silurian and Devonian limestone aquifers. The Brassfield Limestone is the principal aquifer underlying JPG. The limestone aquifers are confined by the overlying fine-grained glacial materials. Wells in the area of JPG range in depth from 50 to 250 feet and yields range from 10 to 100 gallons per minute (USGS, 1985). Groundwater from the limestone aquifers is generally hard with potentially high sulfur contents.

Little information exists for groundwater flow within the JPG facility. Previous monitoring wells were installed for sampling for contaminants, and little aquifer characteristic data have been obtained. However, it is anticipated that groundwater flow rates through the limestone aquifers are generally low to moderate.

Six major streams cross JPG in a northeast to southwest direction. These are Otter Creek, Graham Creek, Little Graham Creek, Big Creek, Middle Fork Creek, and Harberts Creek. Surface-water bodies in addition to the six creeks include two lakes, Old Timbers Lake and Krueger Lake, both of which have been previously stocked with a variety of fish. Also present are several ponds and impoundments.

2.3 Installation History

JPG was established in 1941 as a Class II military installation assigned to the Ordnance Department, Army Services Forces, with the mission of production acceptance and



017 Asbestos Containing Materials (Potentially at many Locations)
018 Underground Storage Tanks (Located at Several Sites)
019 Off-Site Water Supply Wells (not shown on map)

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Figure 2. RI/FS Sites South of the Firing Line at Jefferson Proving Ground

specification testing of all types of ordnance. These included propellants, projectiles, cartridges, mortars, grenades, fuses, primers, boosters, rockets, tank ammunition, mines, and weapon components. Peak production periods at JPG corresponded to times of national conflict such as World War II, the Korean War, and the Vietnam War. Since the 1970's, JPG has experienced a steady decline in production and, in 1988, the installation was identified by the Defense Secretary's Commission on Base Closure and Realignment for closure.

The installation consists of industrial buildings, workshops, and test facilities as well as administrative buildings and personnel housing in the area south of the firing line. This line consists of 268 gun positions that run east-west across the southern portion of JPG. Areas north of the line consist mainly of impact areas with safety fans.

2.4 Previous Investigations

References to previous investigations are found in Section 8.0 of this plan. Several investigations were conducted at JPG covering a variety of environmental concerns. These reports included the following:

- Environmental Impact Assessment (O'Neill, 1978)
- Installation Assessment (USATHAMA, 1980)
- Update of Initial Assessment (Environmental Science and Engineering, 1988)
- RCRA Part B Permit for Open Burning/Open Detonation (U.S. Army Corps of Engineers, 1988)
- Draft RI Technical Report (Environmental Science and Engineering, 1989)
- Enhanced Preliminary Assessment (Ebasco, 1990a)
- Master Environmental Plan (Ebasco, 1990b)
- Environmental Audit (USEPA, 1990)

Although the above investigations have resulted in the identification of numerous potentially hazardous waste sites, little work has been performed to characterize the nature and extent of contamination at JPG. Additional studies will be required to allow JPG to satisfy federal, state, and local environmental laws and regulations and to provide USATHAMA with sufficient data to make informed decisions on remedial action alternatives required to complete the base-closure process.

3.0 Sampling Objectives

This section restates the objectives of the proposed site-specific Remedial Investigation (RI) field and analytical work task presented in the Technical Plan (Volume I). The overall objective of the RI/FS process at JPG is to ensure that there is no significant risk to human health or the environment and to ensure compliance with applicable federal and state laws and regulations. To this end, certain data gaps have been identified that must be filled prior to making decisions on future remedial action and base-closure activities. The scope of this

plan, with the exception of the Gate 19 Landfill Area (sites 14 and 15), is restricted to those areas of JPG that are located south of the firing line. The following are summaries of the objectives previously identified in the Technical Plan (Volume I) for those sites where data gaps exist:

3.1 Building 185 Incinerator

- Confirm the presence or absence of metals contamination in soils downwind of the abandoned incinerator.

3.2 Building 177 Sewage Treatment Plant

- Confirm the presence or absence of potentially hazardous contaminants in Harbert Creek that may be related to sewage-treatment-plant or water-quality-laboratory discharge.
- Determine if soils where on-site storage or disposal of sludge has occurred are contaminated with heavy metals or cyanide.

3.3 Explosive Burning Area

- Confirm the presence or absence of potentially hazardous contaminants in soil as a result of previous burning activities on the ground surface.

3.4 Abandoned Landfill

- Identify the locations of previous buried trenches.
- Evaluate whether a release of contaminants to the environment has occurred as a result of previous landfill burial of potentially hazardous materials.
- Determine if groundwater contamination has occurred if soils are found to be contaminated at depth.

3.5 Wood Storage Pile and Wood Burning Area

- Confirm the presence or absence of pentachlorophenol (PCP), heavy metals, and dioxin in soils from the storage and burning of PCP-containing woods.

3.6 Red Lead Disposal Area

- Determine the exact location of the former Red Lead Disposal Area.
- Once the location is defined, confirm the presence or absence of lead and barium in the soils at the former disposal site.
- Provide initial site-characterization data on the vertical and horizontal extent of contaminants.

- Determine if groundwater contamination has occurred if contamination in soils is present at depth.

3.7 Small Arms Firing Range

- Identify contaminants present within the building and their relative concentrations.
- Confirm the presence or absence of metals contamination outside of the building in surface soils.
- On the basis of contaminants found, assess the potential risk to human health and need for further studies.

3.8 Burning Ground (South of Gate 19 Landfill)

- Define the location of previous trenches.
- Determine if releases of contaminants have occurred in surface and subsurface soils.
- Determine if releases of contaminants have occurred in the surface-water pathway near the burning ground.
- Provide initial site-characterization data on the vertical and horizontal extent of contamination if present.
- Determine if releases of contaminants have occurred to the groundwater pathway.

3.9 Gate 19 Landfill

- Evaluate validity of previous groundwater sampling and analysis results to determine if the detection of mercury and volatile organic compounds (VOCs) calls for additional groundwater monitoring.
- Identify specific areas within the landfill where metal containers or other metal debris have been disposed of that may be potential sources of contamination.
- Identify specific areas within the landfill where spent solvents were disposed of.
- Provide initial data on the vertical and horizontal extent of contamination associated with identified disposal sites within the landfill.
- Provide additional data on occurrence and extent of groundwater contamination and the groundwater-migration pathway.

3.10 Burning Area for Explosive Residue

- Sample areas of surface staining to determine if potentially hazardous contaminants have been released to the soils at the site.
- If contaminants are found to exist at depth, obtain groundwater-sample data to determine if contaminants have entered the groundwater pathway.

3.11 Building Solvent Pits (Buildings 602, 617, and 279)

- Further define the extent of VOC contamination in soils surrounding Building 279.
- Confirm the presence or absence of VOC contamination in soils at Buildings 602 and 617.
- Provide initial groundwater quality data at the Building 602 and 617 sites and additional groundwater data at Building 279.

3.12 Old Fire Training Pit

- Determine the presence or absence of contamination in soils.
- Provide initial data on the vertical and horizontal extent of contamination if present.
- Determine if contaminants have been released to the groundwater pathway.

3.13 Yellow Sulfur Disposal Area

- Confirm the presence or absence of contamination in the surface water pathway.
- Identify contaminants in soils associated with the sulfur disposal.
- Determine if contaminants have migrated to the groundwater pathway.

3.14 Burn Area South of New Incinerator

- Confirm the presence or absence of contaminants in surface soils and on the concrete pad.

3.15 Potential Ammo Dump Site

- Determine the location of the dump site.
- Evaluate the contents of the dump site by digging test pits.

3.16 Asbestos Containing Materials

- Conduct inventory and identify all potential asbestos-containing materials.
- Perform laboratory analysis, as required, to confirm asbestos materials.
- Prepare a report with recommendations for asbestos abatement.

3.17 Underground Storage Tanks

- Perform follow-on sampling to determine extent of contamination for known or suspected leaking underground storage tanks (USTs).

3.18 Off-site Water Supply Wells

- Perform site inspection and soil sampling to determine if contaminants have been released to environmental pathways.

3.19 Temporary Waste Storage Areas (Buildings 279 and 305)

- Determine the presence or absence of contamination in soil and on building surfaces.
- Identify contaminants in soils and on building surfaces associated with waste storage.

3.20 Temporary Storage Areas (Buildings 105, 186, 204, 211 and 227)

- Determine the presence or absence of contamination in soil and on building surfaces.
- Identify contaminants in soils and on building surfaces associated with waste storage.

3.21 Groundwater System South of the Firing Line

- Assess the groundwater-system parameters and potential for lateral and vertical flow in the shallow alluvial and bedrock aquifers.

4.0 PROPOSED FIELD-INVESTIGATION WORK TASKS

This section describes the proposed field-investigation activities to be performed in support of the RI/FS at JPG. Location maps are provided that show the general location of proposed samples or field measurements. Detailed step-by-step procedures to be used during the field activities are presented in Appendix A. Table 1 provides a summary of the proposed field activities.

4.1 Building 185 Incinerator

4.1.1 *Surface Soil Sampling*

The Building 185 incinerator (see Figure 3) consists of a Morse-Bouler, single-chamber, single-burner, single-stack incinerator without an afterburner unit. The incinerator was used from approximately 1941 to 1978 to burn debris, small ammunition, and paper products at the installation.

No previous data exist for the Building 185 incinerator. Although a lack of evidence for significant risk to human health or the environment exits, two near-surface soil samples (0 to 1 foot) will be taken from the two principle downwind directions to determine if metal contaminants are present in soils surrounding the abandoned incinerator. These samples will be analyzed for toxicity characteristic leaching process (TCLP) metals.

Table 1. Summary of Proposed RI/FS Field Activities

SITE	Geophysical Survey	UXO Survey	Surface Soil	Subsurface Soil	Stream Sediment	Surface Water	Ground Water	Wipe Samples	ANALYTES
Bldg 185 Incinerator	—	—	2	—	—	—	—	—	TCLP Metals
Bldg 177 Sewage Treatment Plant	—	—	2	—	5	—	—	—	TCLP Metals, Cyanide, TPH
Explosive Burning Area	—	—	16	—	—	—	—	—	Explosives, TCLP Metals
Abandoned Landfill	2	1	—	12	—	—	3	—	VOCs, semi-VOCs, TCLP Metals and Explosives
Wood Storage Pile	—	—	2	—	—	—	—	—	VOCs, Semi-VOCs, PCP, and dioxin
Wood Burning Pile	—	—	2	—	—	—	—	—	VOCs, Semi-VOCs, PCP, and dioxin
Red Lead Disposal Area	—	—	—	20	—	—	3	—	TCLP Metals
Small Arms Firing Range	—	—	4	—	—	—	—	40	TCLP Metals
Burning Ground	2	1	16	36	3	3	1	—	VOCs, semi-VOCs, TCLP Metals and Explosives
Gate 19 Landfill	2	—	10	30	—	—	4	—	BTEX (soil gas), VOCs, semi-VOCs, TCLP Metals
Burning Area for Explosive Residue	—	—	10	12	—	—	3	—	DNT, TNT, TCLP Metals, Herbicides
Bldgs 602, 617, and 279 Solvent Pits	—	—	—	48	—	—	8	—	VOCs
Old Fire Training Pit	—	—	—	20	—	—	3	—	VOCs, semi-VOCs, TCLP Metals
Yellow Sulfur Disposal Area	—	1	—	18	4	4	3	—	Sulfur, TCLP, Metals, pH
Burn Area South of New Incinerator	—	—	4	—	—	—	—	1	explosives, metals, VOCs, semi-VOCs
Potential Ammo Dump Site	2	1	—	—	—	—	—	—	No samples
Underground Storage Tanks	—	—	—	48	—	—	—	—	TPH, BTEX
Off-Site Water Supply Wells	—	—	—	6	—	—	—	2	TPH, BTEX
Waste Storage Bldgs 279 and 305	—	—	—	48	—	—	—	32	VOCs, semi-VOCs, TCLP metals, PCB/pesticides
Storage Bldgs 105, 186, 204, 211, and 227	—	—	15	—	—	—	—	15	semi-VOCs, TPH, TCLP metals, pesticides

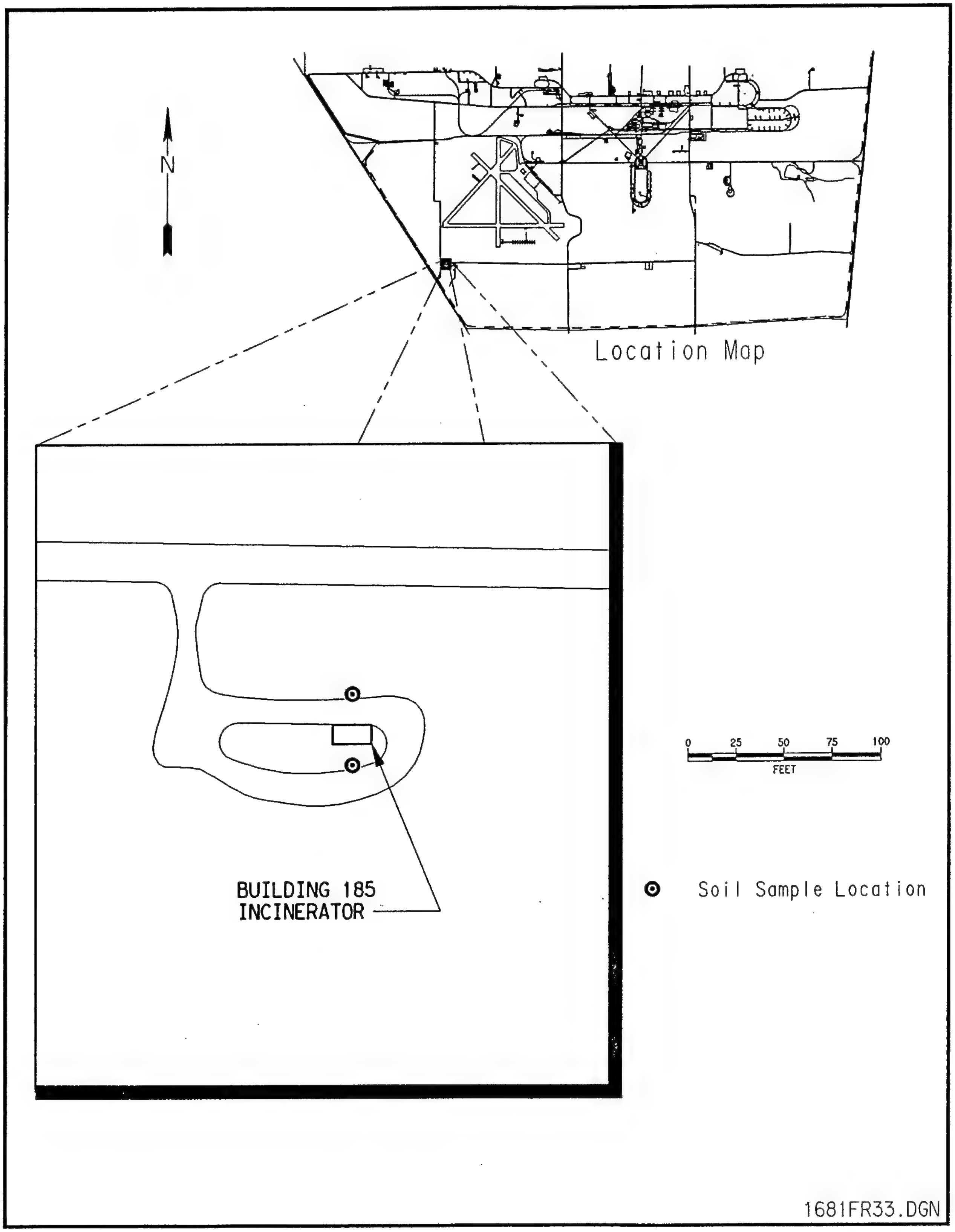

Figure 3. Proposed Sampling Locations at Building 185 Incinerator

4.2 Building 177 Sewage Treatment Plant

4.2.1 *Sediment Sampling*

Contaminants may have entered Harberts Creek from discharge of industrial waste through the wastewater-treatment-plant outfall. The following sediment-sampling activities are required to determine if these releases have occurred. Figure 4 shows the proposed sampling locations for sediment samples in Harberts Creek. Three downstream samples will be collected with the first sample being located 50 feet downstream of the sewage-treatment-plant outfall. The remaining downstream locations are spaced every 50 feet downstream of the first location.

Two upstream samples will be collected with the first sample being located 50 feet upstream of the sewage-treatment-plant outfall. The second sample will be collected 50 feet upstream of the first sample.

The sediment samples will be grab samples collected with a stainless-steel scoop at a depth of 0 to 6 inches. For samples to be analyzed for TCLP metals and cyanide, the material will be collected near the mid-point of the drainage channel. Samples for total petroleum hydrocarbons (TPH) analysis will be collected from the portion of the bank representing the average water level.

4.2.2 *Soil Sampling*

An area where on-site storage of sewage sludge occurred will be located on the basis of previous information and will be sampled to determine if contaminants from the sludge were leached into the surrounding soils. Two surface-soil samples will be collected from a depth of 0 to 1 foot using a stainless-steel hand-operated barrel auger. These samples will be analyzed for TCLP metals and cyanide. If these samples are found to contain contaminants exceeding background concentrations, additional sampling and location of other areas of storage and disposal may be required.

4.3 Explosive Burning Ground

4.3.1 *Surface Soil Sampling*

A grid covering an area of approximately 100 by 100 feet will be established across the mid portion of the 2-acre site (Figure 5). Near the center of each grid, a near-surface soil sample will be collected at a depth of 0 to 2 feet using a stainless-steel hand-operated barrel auger. The sample material will be a composite of the 2-foot interval. This will result in the collection of 16 soil samples that will be analyzed for explosives and TCLP metals. The corner points of the sample grid will be surveyed to a known coordinate system, and sample locations will be determined by measurements from the established corner points using a tape measure and line-of-site with the corner points and other grid locations.

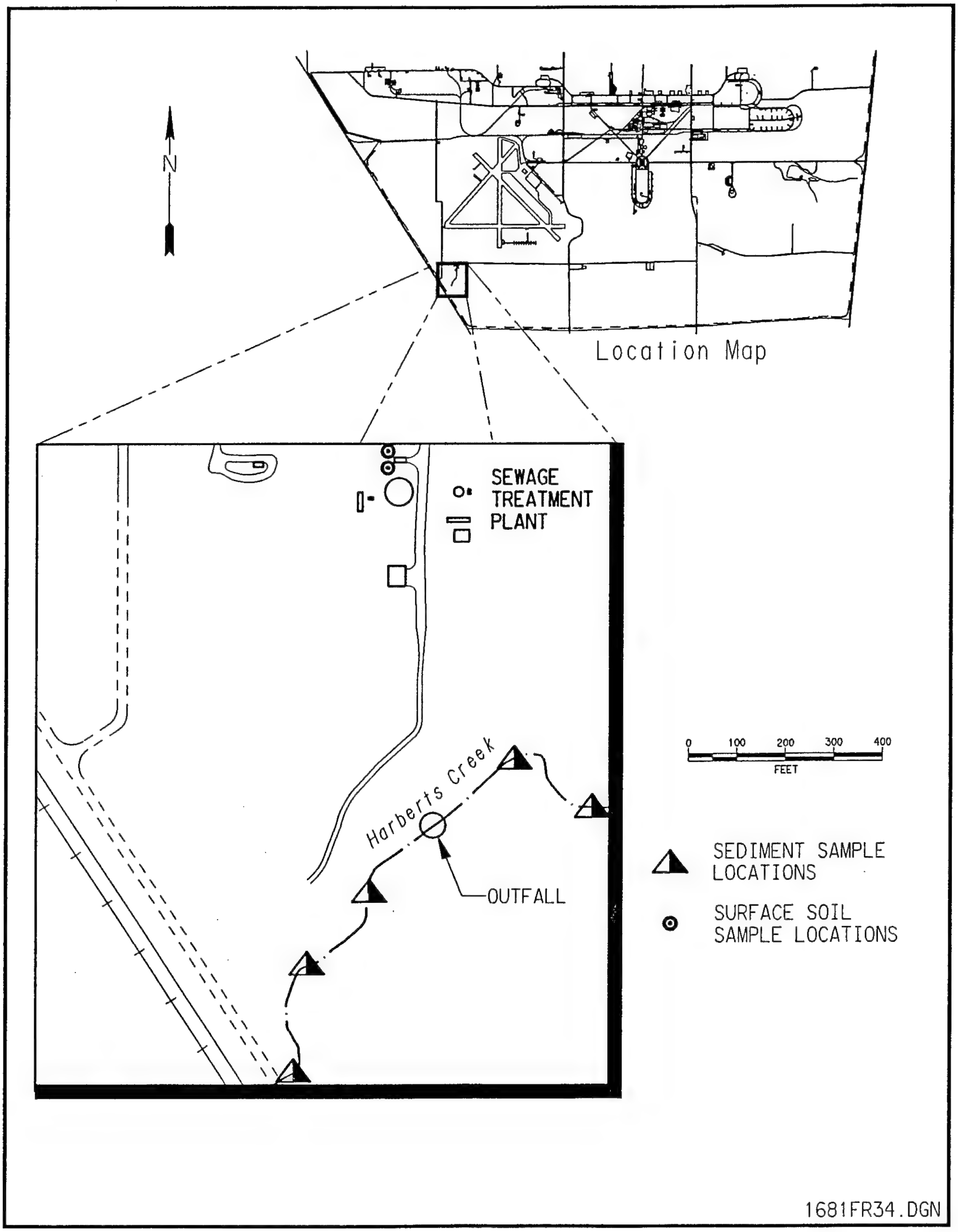

Figure 4. Proposed Sampling Locations at Building 177 Sewage Treatment Plant

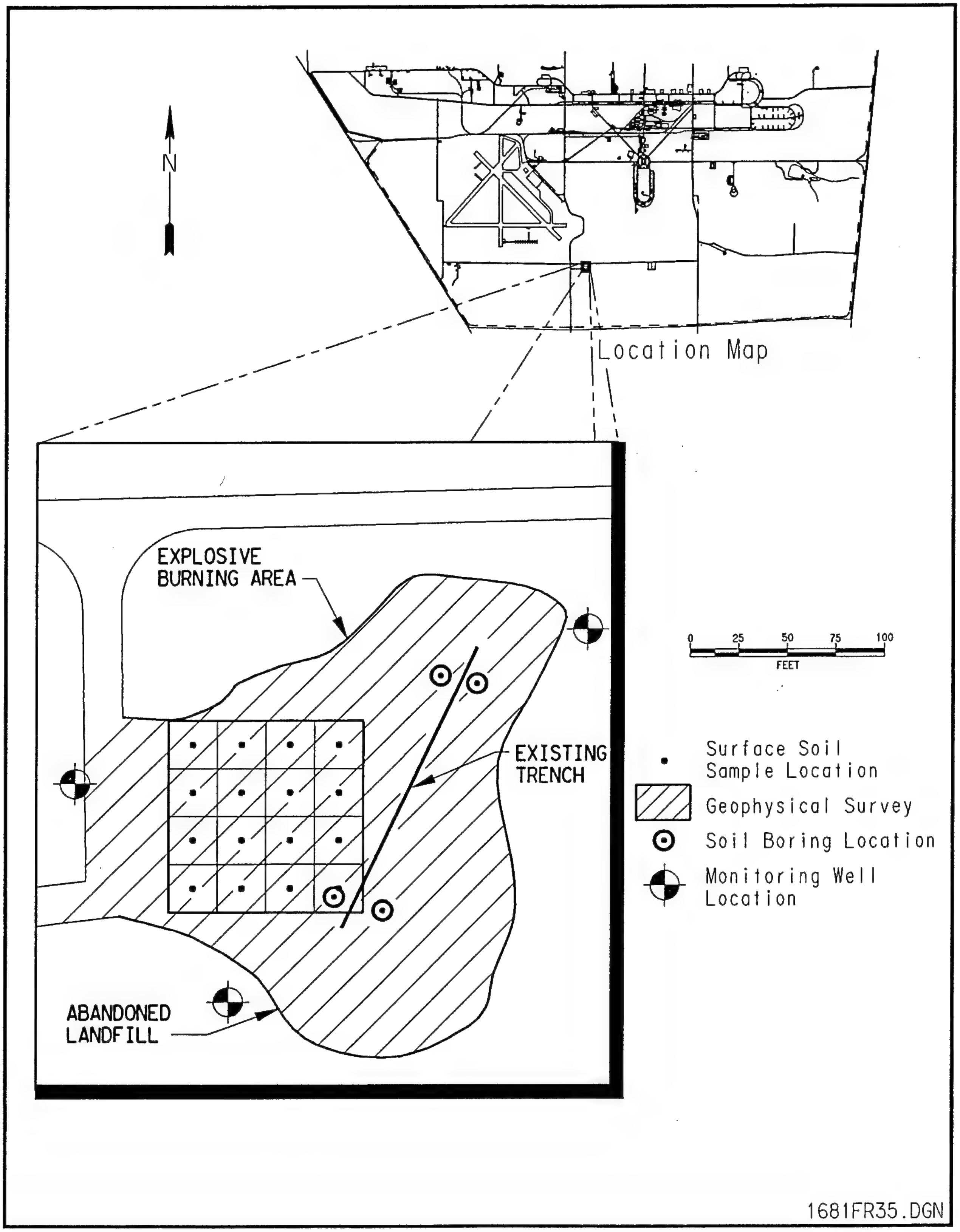

Figure 5. Proposed Sample Location at Explosive Burning Area and The Abandoned Landfill

4.4 Abandoned Landfill

4.4.1 *Geophysical Surveys*

Magnetometry and ground penetrating radar (GPR) will be used to determine the location of buried trenches at the abandoned landfill. The surveys will be conducted across the landfill area on a 20-foot grid spacing (Figure 5). Results will be plotted on a grid map with anomalies identified and marked. For areas where anomalies occur, a closer-spaced survey may be conducted (i.e., 10-foot spacing), if deemed necessary to clearly define the trench locations.

4.4.2 *Soil Borings and Sampling*

Once the trench boundaries have been defined, soil borings will be drilled using a hollow-stem auger rig. A stainless-steel split-barrel sampler will be used to obtain soil cores at depths of 4-to-5-foot, 9-to-10-foot, and 14-to-15-foot intervals. The hollow-stem auger with a retrievable center bit in place will be used to drill to the top of the desired sampling depth. The center bit will then be removed and a split-barrel sampler will be driven for the length of the desired sample interval and will then be removed for sample collection. Samples will be analyzed for VOCs, semi-VOCs, TCLP metals, and explosives. Samples (1 in 20) will also be collected for physical testing per USATHAMA Geotechnical Requirements (Appendix B).

4.4.3 *UXO Screening*

Due to the unknown nature of the contents of the abandoned landfill, unexploded-ordnance (UXO) personnel will be utilized to provide surface and downhole screening support for UXO. Each boring location will be scanned with a magnetometer prior to the start of drilling. Once a depth of 5 feet has been reached, the augers will be pulled and the drill rig moved to allow down-hole logging for buried metal objects. This protocol, required by USATHAMA, will be followed for every 5 feet of drilling. If a location cannot be cleared, the location will be moved to a location that can be cleared.

4.4.4 *Groundwater Monitoring Well Installation and Sampling*

If subsurface soil samples are found to contain above background concentrations of contaminants, two downgradient and one upgradient monitoring wells will be installed. Drilling will proceed to the top of the water table and will be continued another 8 feet to allow the installation of 10 feet of screen with the top 2 feet of the screen being above the water table to allow for fluctuations in water levels. If no water is encountered at this depth, then drilling will continue to the first water-producing zone in the bedrock, not to exceed 50 feet. The installation of monitoring wells will conform to all USATHAMA Geotechnical Requirements (Appendix B).

Groundwater samples will be collected from each well following proper development and purging. Detailed procedures to be used in the collection of groundwater are located in Appendix A. Groundwater samples will be analyzed for contaminants of concern as determined by subsurface-soil-sampling analytical results or by review of previous investigations of installation operations.

4.5 Wood-Storage Pile and Wood-Burning Area

4.5.1 *Soil Sampling*

No data currently exist for the two wood-storage sites. A previous report (Ebasco, 1990b) recommended no further action was needed for these two locations. However, limited soil contaminants may have been released and transported to surface soils via storm runoff. To determine the extent of this release, four surface samples will be taken at locations shown in Figure 6 and analyzed for VOCs, semi-VOCs, PCP, and dioxin.

4.6 Red-Lead Disposal Area

4.6.1 *Test Corings*

In the area of reported red-lead (Pbo) disposal, three parallel lines will be established using a tape and line-of-site for a distance of 100 feet for each line (see Figure 7). Pin flags will be established every 20 feet along these lines. At each pin-flag location, a stainless-steel hand-coring device will be used from the surface to a depth of 2 feet in order to obtain a soil core. The soil core will be removed from the coring device and will be examined for evidence (coloration, staining, layering, debris, or other evidence) of red-lead or barium-sulfate disposal. This protocol will continue until evidence of the red-lead disposal site is obtained.

4.6.2 *Soil Core Sampling*

For those locations where visual evidence exists, the core samples will be collected and analyzed for TCLP metals.

4.6.3 *Soil Borings and Sampling*

On the basis of soil-core analysis, a minimum of four soil borings will be drilled using a hollow-stem auger rig to a depth of 10 feet at locations found to contain heavy metals. Samples from these borings will be collected using a stainless-steel split-barrel sampler at depths of 2 to 4, 4 to 6, 6 to 8, and 8 to 10 feet to determine the vertical distribution of metals contamination.

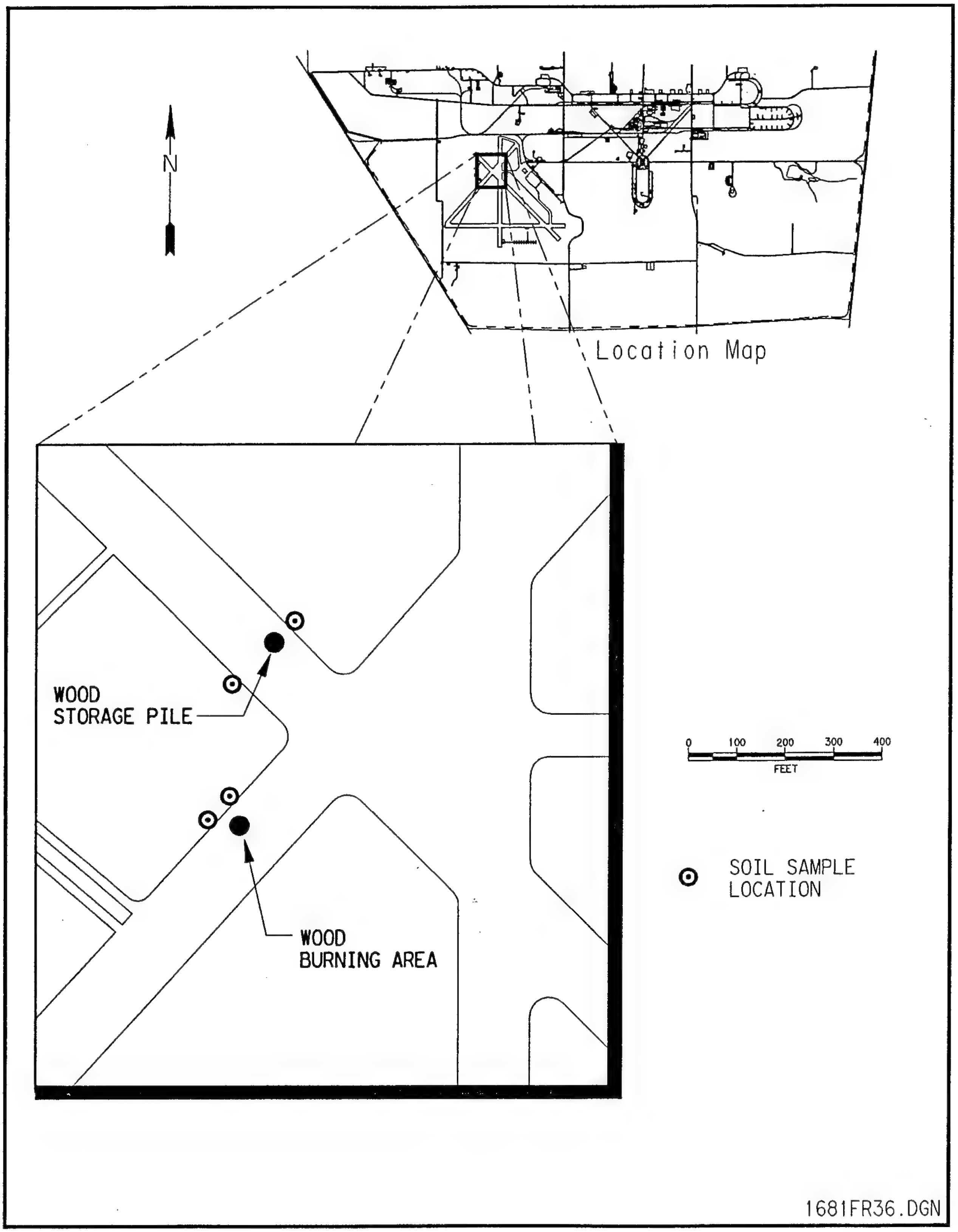

Figure 6. Proposed Sampling Location at Wood Storage Pile and Wood Burning Area

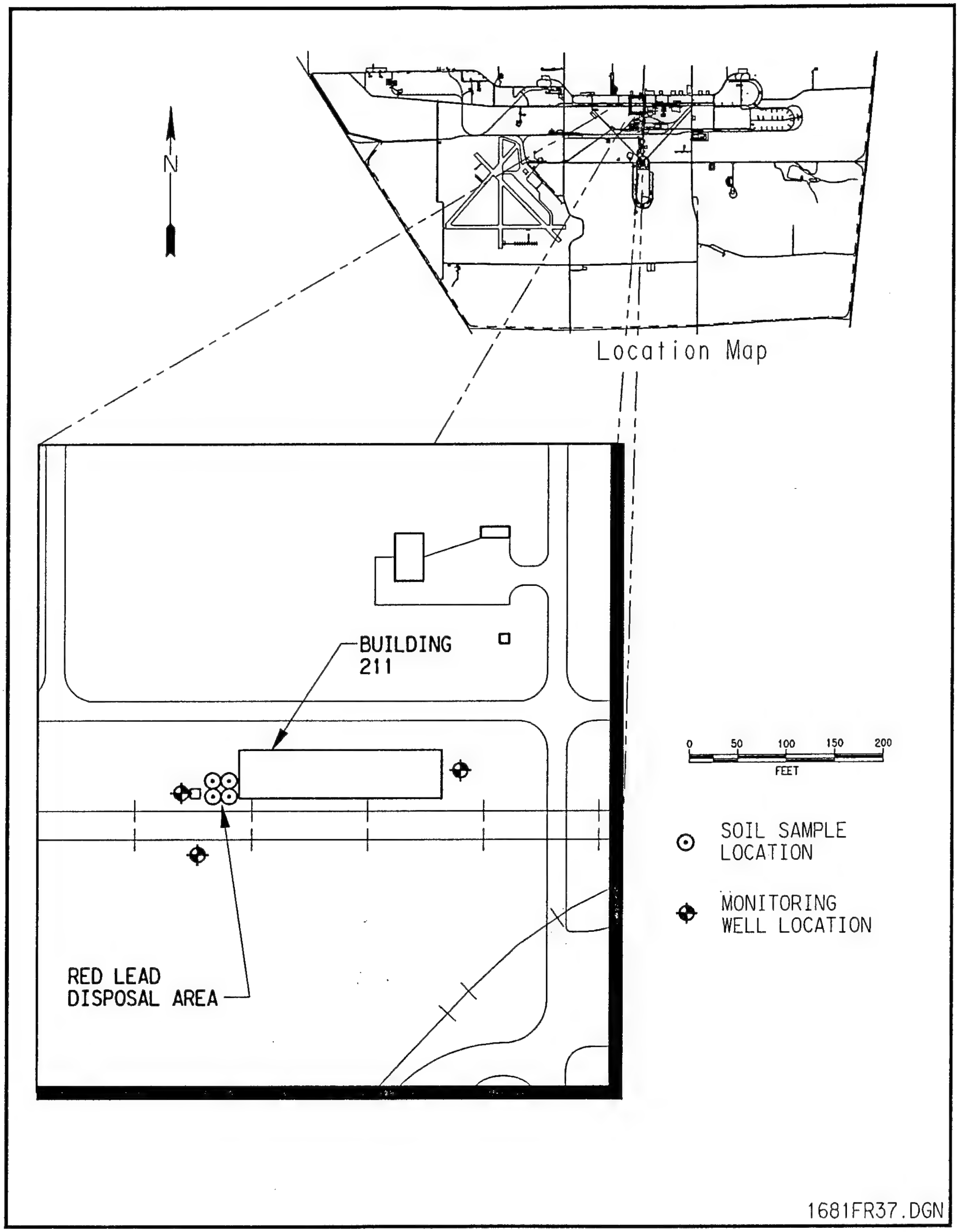

Figure 7. Proposed Sampling Locations at The Red-lead Disposal Area

4.6.4 *Groundwater-Monitoring Well Installation and Sampling*

If soil-sample data collected from the 10-foot interval indicate that elevated concentrations of metals are present at depth, two downgradient monitoring wells and one upgradient monitoring well will be drilled, installed, and sampled to determine if releases of metals at this site have impacted groundwater quality. Monitoring-well installation will be completed in accordance with USATHAMA geotechnical requirements (Appendix B). Detailed procedures for sample collection are presented in Appendix A.

4.7 Small-Arms Firing Range

4.7.1 *Sampling of Suspected Asbestos-Containing Materials*

Pieces of wall tile suspected to contain asbestos will be collected and sent for laboratory analysis for asbestos. This sample will be a composite sample of material collected from several tile locations within the building.

4.7.2 *Unidentified White-Powder Sampling*

One composite sample of the white material observed in an abandoned test facility will be collected and analyzed for explosives and TCLP metals.

4.7.3 *Wipe Sampling*

Wipe samples will be collected from the walls, floor, and ceiling of each firing range to determine the amount of residual metals from previous testing of small arms. The wipe samples will be analyzed for heavy metals. Approximately 10 wipe samples will be collected from each firing lane.

4.7.4 *Surface-Soil Sampling*

Four surface-soil samples will be collected around the perimeter of the building with samples being analyzed for TCLP metals (see Figure 8).

4.8 Burning Ground (South of Gate 19 Landfill)

4.8.1 *Geophysical Surveys*

A magnetometer and GPR survey will be conducted to help define the location of pits and trenches in the former burning area south of the Gate 19 Landfill. These surveys will be conducted on a 20 foot grid spacing across the suspected burning-site location (see Figure 9). A plot of the results will be generated and anomalies will be plotted and interpreted. If necessary for better definition, the areas containing geophysical anomalies will be resurveyed using a closer spacing (i.e., 10-foot spacing).

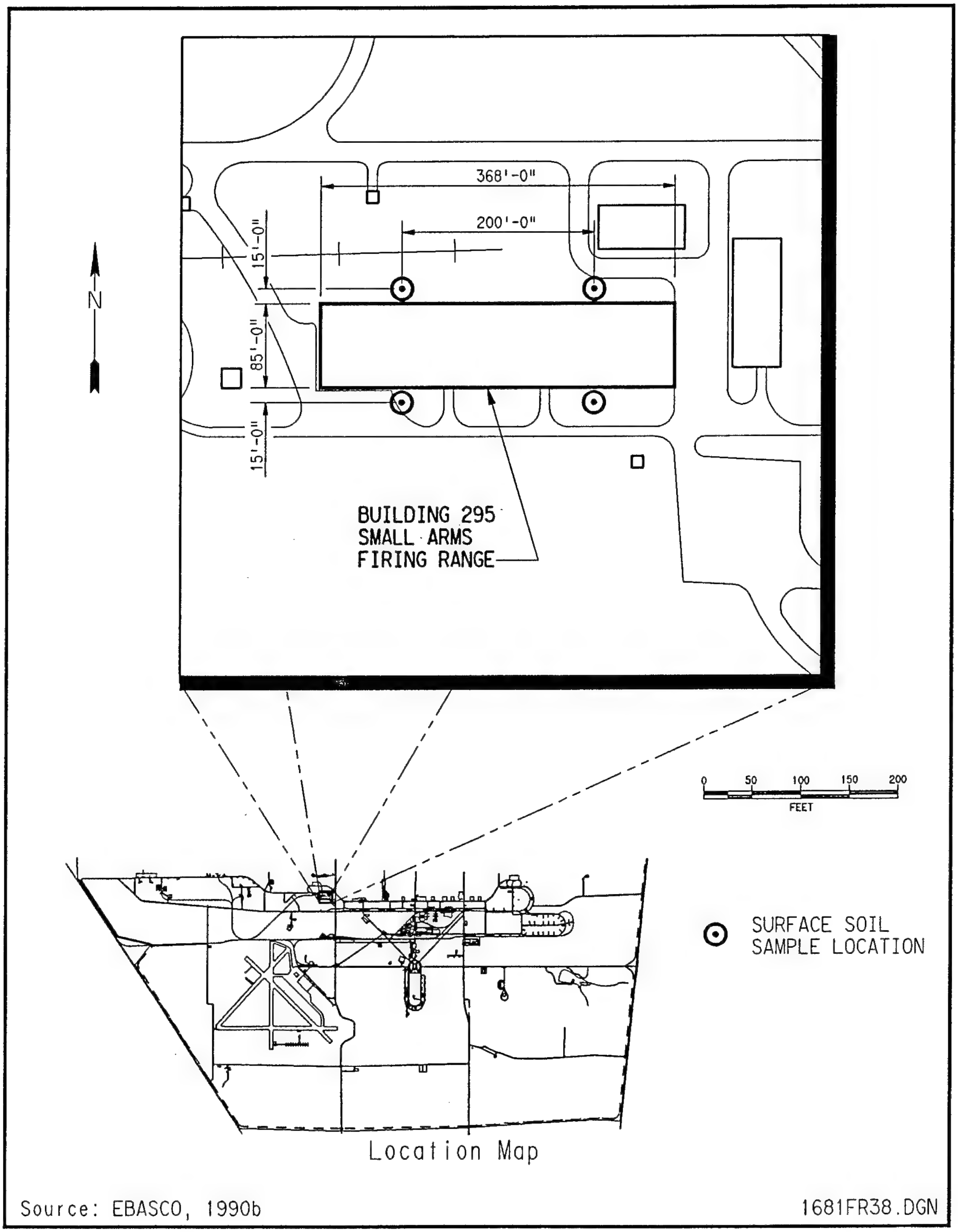

Figure 8. Proposed Sampling Locations at Building 295

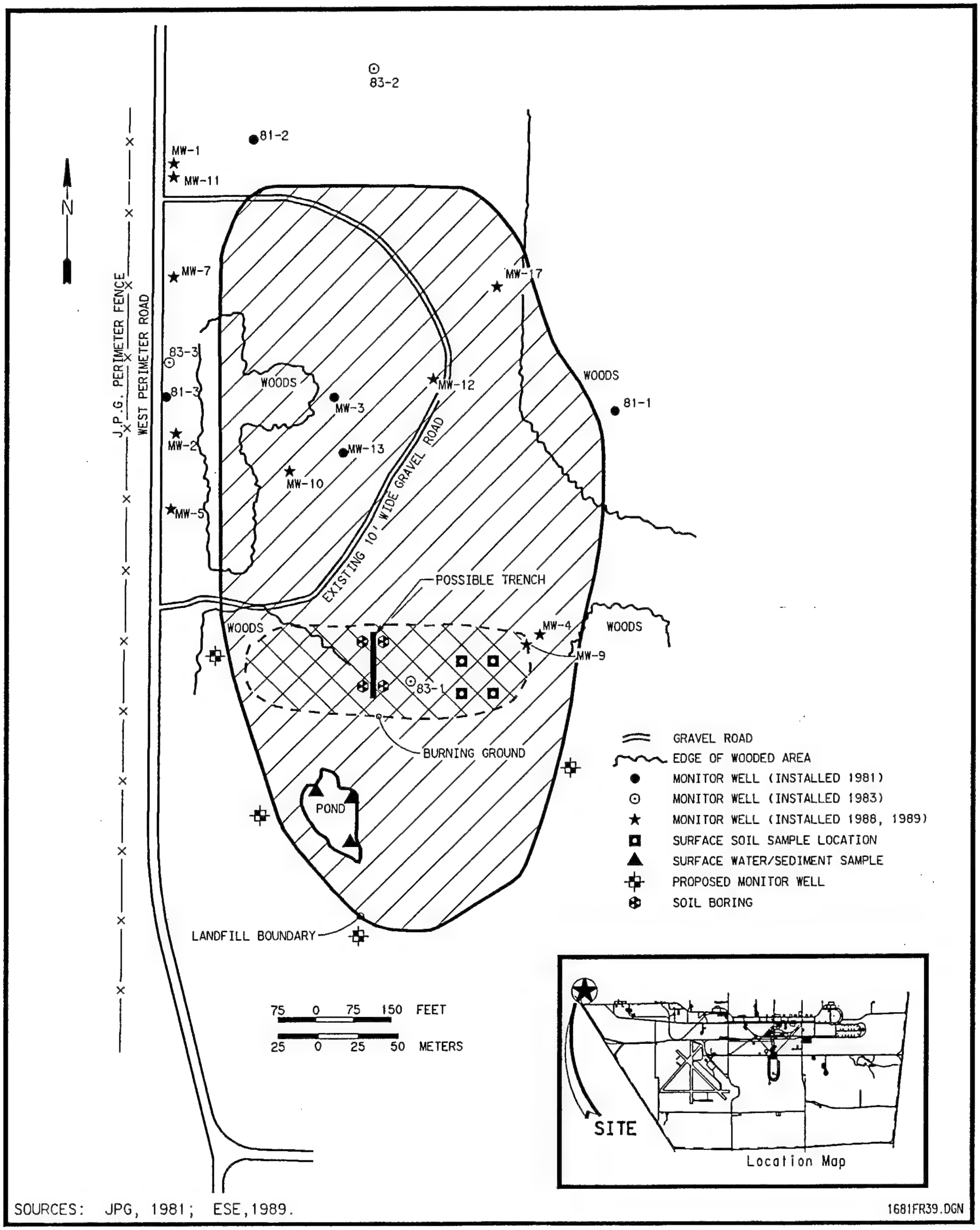

Figure 9. Proposed Sampling Locations at the Gate 19 Landfill and the Burning Ground

4.8.2 *Soil Borings and Sampling*

On the basis of the geophysical survey, soil borings will be drilled on the outside perimeter of any pits or trenches identified. These borings will be drilled with a hollow-stem auger to a depth of 10 feet with samples being collected at the surface, 4 to 5 feet and 9 to 10 feet, with a stainless-steel split-barrel sampler. Samples collected will be analyzed for VOCs, semi-VOCs, TCLP metals, and explosives.

4.8.3 *Surface Soil Sampling*

If visual evidence of surface burning is present, four surface-soil samples will be collected from each surface burn area that is identified (i.e., debris or surface staining). These samples will be grab samples from a depth of 0 to 6 inches using a stainless-steel scoop. These samples will be analyzed for VOCs, semi-VOCs, metals, and explosives.

4.8.4 *Unexploded Ordnance Survey*

Prior to the start of work at the burning ground site, a surface sweep of the area will be conducted by UXO personnel. At locations of proposed soil borings, a magnetometer survey of the drill area will be conducted for UXO. As drilling proceeds, downhole screening of the borehole by UXO personnel will be performed every 5 feet for the presence of buried metal. For any boring that cannot be cleared by UXO screening, the boring will be relocated. Direct drilling of pits and trenches will be avoided due to the unknown nature of the materials potentially disposed of at the site.

4.8.5 *Groundwater-Monitoring Well Installation and Sampling*

If evidence of subsurface contamination is present, one of the soil borings will be deepened to the water table and completed as a monitoring well. Water samples will be collected and analyzed for VOCs, semi-VOCs, metals, and explosives.

4.8.6 *Surface-Water and Sediment Sampling*

Surface water and sediment samples will be collected from the pond near the burning area and analyzed for VOCs, semi-VOCs, metals, and explosives.

4.9 Gate 19 Landfill

4.9.1 *Geophysical Surveys*

Magnetometry and GPR surveys will be conducted across the Gate 19 Landfill to locate specific disposal areas of metal wastes that may hold drums, paint containers, pesticide containers, etc. The survey will be conducted using a 20-foot grid spacing. Anomalies will

be identified on a plot of the landfill and will be compared with previous landfill drawings, aerial photography, or disposal records (if available).

4.9.2 *Groundwater Monitoring Well Installation and Sampling*

Several existing wells will be resampled for mercury and VOCs. Four additional wells will be installed and sampled around the south end of the Landfill (see Figure 9). Samples will be collected and analyzed for VOCs, semi-VOCs, and metals.

4.9.3 *Soil Borings and Sampling*

On the basis of the geophysical survey, specific areas of potential contamination will be identified as target areas for soil borings and sampling. Soil borings to a depth of 10 feet will be drilled using a hollow-stem auger rig around the perimeter of anomalous areas with samples collected from 0 to 1 foot, 4 to 5 feet, and 9 to 10 feet using a stainless-steel split-barrel sampler. Samples will be analyzed for VOCs, semi-VOCs, and TCLP metals. An estimated 10 borings will be drilled yielding 30 soil samples. The surface/near-surface samples will be used to determine if the cover soil has been contaminated or is "clean." This information will be used to evaluate the potential for contaminant migration via the surface-water pathway and to determine risks associated with the air pathway (i.e., particulates, VOCs).

4.9.4 *Receptor/Pathway Analysis*

Data on nearby water supply wells and demographics will be collected as part of the receptor/pathway analysis. Nearby drainages will be inspected for obvious seeps and springs as evidence of groundwater discharging into surface water.

4.10 Burning Area for Explosive Residue

4.10.1 *Surface Soil Sampling*

Biased sampling will be performed at the burning area with sample locations determined on the basis of discolored gravel or surface-soil staining. Approximately 10 surface soil samples will be collected (0 to 6 inches) with a stainless-steel scoop from these stained areas (see Figure 10). The samples will be analyzed for TCLP metals, explosives, and herbicides. In addition, one of the samples will be analyzed for VOCs and semi-VOCs to determine if an organic catalyst used for igniting the explosive residue resulted in organic-compound contamination. Soils will be scanned with a photoionization detector (PID) at each sample location. The sample location for VOC and semi-VOC analysis will be selected on the basis of this scan.

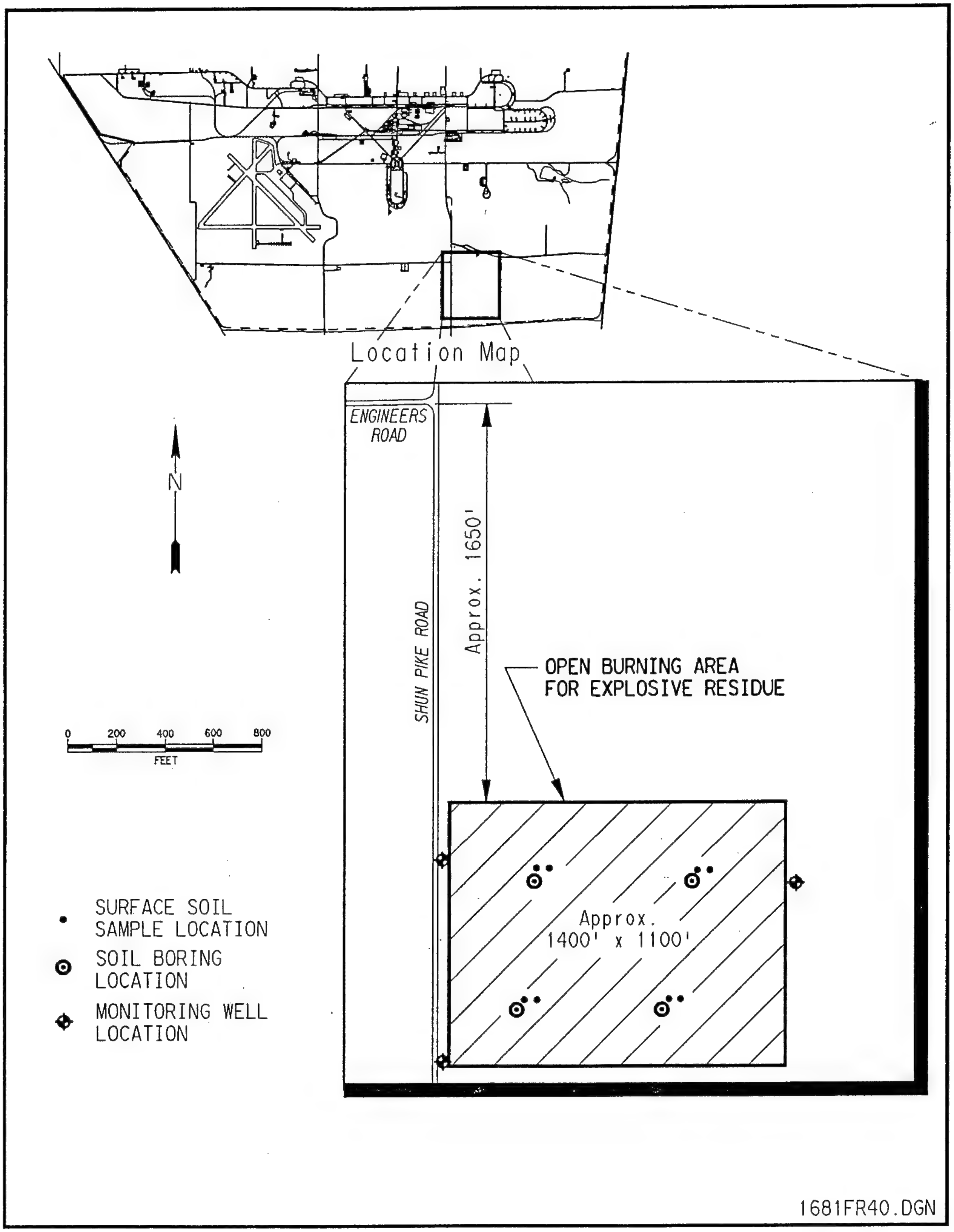

Figure 10. Proposed Sampling Locations at the Burning Area for Explosive Residue

4.10.2 *Soil Borings and Sampling*

Four of the locations of surface stains will be selected for the drilling of a soil boring using a hollow-stem auger rig to a depth of 10 feet (see Figure 10). These borings will be sampled using a stainless-steel split-barrel sampler at depths of 0 to 1 foot, 4 to 5 feet, and 9 to 10 feet. These samples will also be analyzed for TCLP metals, explosives, and herbicides. Samples will be scanned with a PID. If elevated readings are encountered, selected samples will be analyzed for VOCs and semi-VOCs.

4.10.3 *Groundwater-Monitoring Well Installation and Sampling*

If analytical results of subsurface-soil samples at the 9-to-10-foot level indicate that downward migration of contaminants has occurred, two downgradient monitoring wells and one upgradient monitoring well will be drilled, installed, and sampled to determine the water quality at the burning area (see Figure 10). Monitoring-well installation will be performed in accordance with the geotechnical requirements established by USATHAMA (Appendix B). Detailed sampling procedures are included in Appendix A. Groundwater samples will be analyzed for TCLP metals, explosives, herbicides, VOCs, and semi-VOCs.

4.11 Building Solvent Pits (Buildings 602, 617, and 279)

4.11.1 *Soil Borings and Sampling*

VOC contamination was previously identified at Building 279 through soil-gas sampling. Contaminants were also detected in groundwater from one of the monitoring wells located near the former solvent pit. Four soil borings will be drilled around the perimeter of the solvent pit (see Figure 11) to a depth of 10 feet using a hollow-stem auger rig. Soil samples will be collected using a stainless-steel split-barrel sampler at depths of 0 to 1 foot, 4 to 5 feet, and 9 to 10 feet and analyzed for VOCs. In addition, soil core/cuttings will be scanned with a PID to determine if other zones of contamination exist. Biased sampling may be performed in addition to the specified intervals. One of the soil borings will be drilled within the building through the concrete floor. If access is available, the drill rig will be used. If necessary, a hand-operated power auger will be used within the building in place of a drill rig to assess contamination under the building floor. Coring of the concrete to allow access for the power auger would be accomplished with a diamond-bit concrete corer.

Four soil borings will be drilled around the perimeter of the solvent pits at Buildings 602 and 617 (Figures 12 and 13), including one boring within the building as described for Building 279 above. These borings will be sampled using the same sampling protocol used for Building 279. Samples will be analyzed for VOCs.

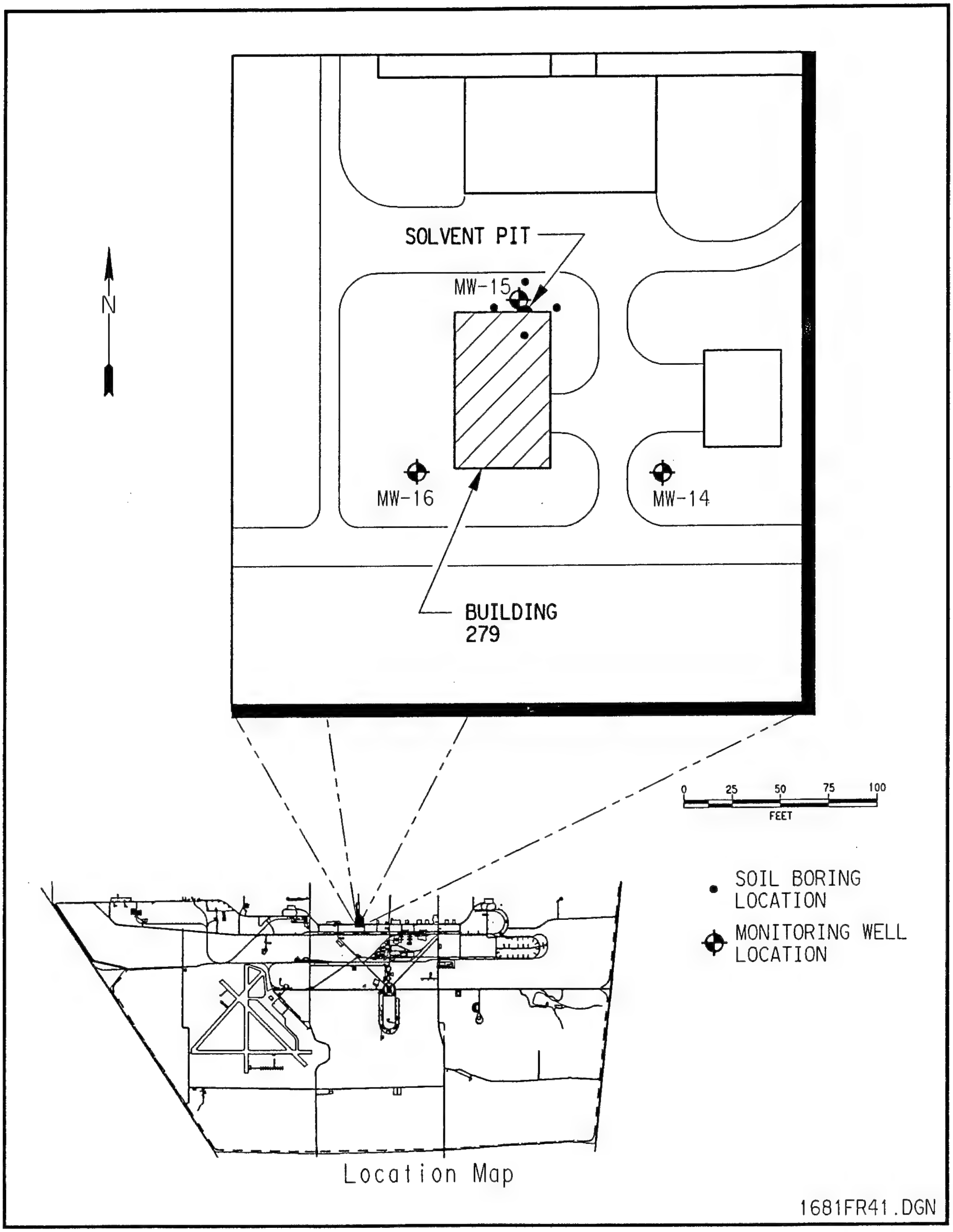

Figure 11. Proposed Sampling Locations at Building 279 Solvent Pit

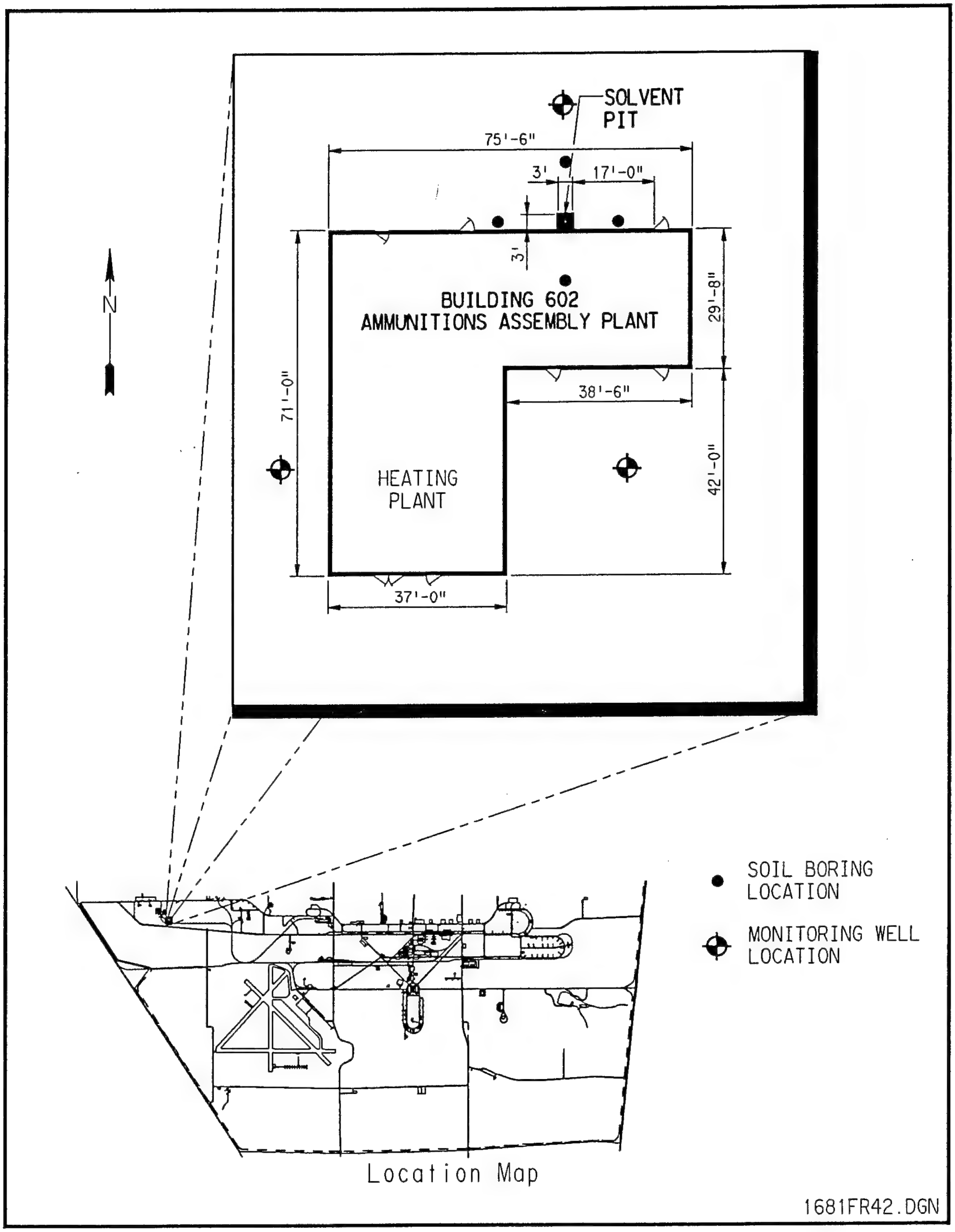

Figure 12. Proposed Sampling Locations at Building 602 Solvent Pit

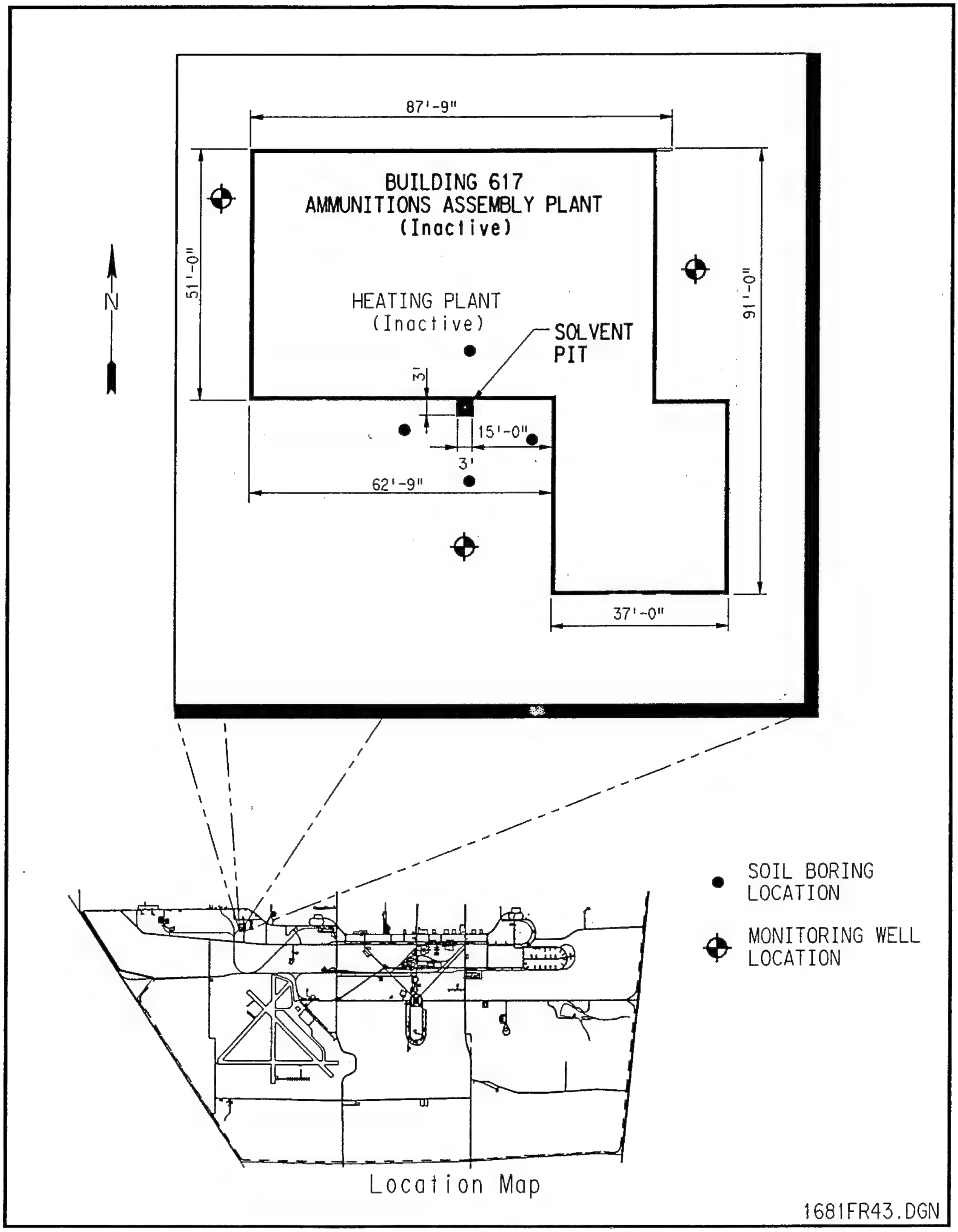

Figure 13. Proposed Sampling Locations at Building 617 Solvent Pit

4.11.2 *Groundwater-Monitoring Well Installation and Sampling*

If subsurface-soil contamination is present on the basis of soil-boring sample results, one upgradient monitoring well and two downgradient monitoring wells will be installed and sampled at Buildings 602 and 617. Two additional wells will be installed at Building 279 to evaluate groundwater-contaminant plume limits. Samples will be analyzed for VOCs. Monitoring wells will be installed in accordance with USATHAMA geotechnical requirements (Appendix B). Sampling will be conducted according to procedures presented in Appendix A.

4.12 Old Fire Training Pit

4.12.1 *Soil Borings and Sampling*

Four soil borings will be drilled around the perimeter of the old fire training pit using a hollow-stem auger rig (see Figure 14). The borings will be drilled to a nominal depth of 15 feet with samples collected using a stainless-steel split-barrel sampler at depths of 0 to 1 foot, 4 to 5 feet, 9 to 10 feet, and 14 to 15 feet. In addition, one boring will be drilled near the approximate center of the pit using the same sampling protocol. Samples will be analyzed for VOCs, semi-VOCs, and TCLP metals.

4.12.2 *Groundwater Monitoring Well Installation and Sampling*

One upgradient monitoring well and two downgradient monitoring wells will be installed at the old fire training pit site if samples collected from the 9-to-10-foot or 14-to-15-foot intervals contain elevated concentrations of contaminants (through field observation and screening with a PID). If contamination appears to be surface or near-surface, no groundwater-monitoring wells will be installed.

4.13 Yellow Sulfur Disposal Area

4.13.1 *Stream Sediment Sampling*

Four sediment samples will be collected from the surface-water drainage located adjacent to the yellow sulfur disposal area. These samples will be collected from points within the drainage located approximately every 50 feet downstream of the sulfur disposal site (see Figure 15). The sediment samples will be collected as grab samples using a stainless-steel scoop from a depth of 0 to 6 inches. The samples will be analyzed for sulfur, TCLP metals, and pH.

4.13.2 *Surface-Water Sampling*

Four surface-water samples will be collected at the same locations as the sediment samples if running surface water is present at the time of sampling. These samples will be collected by

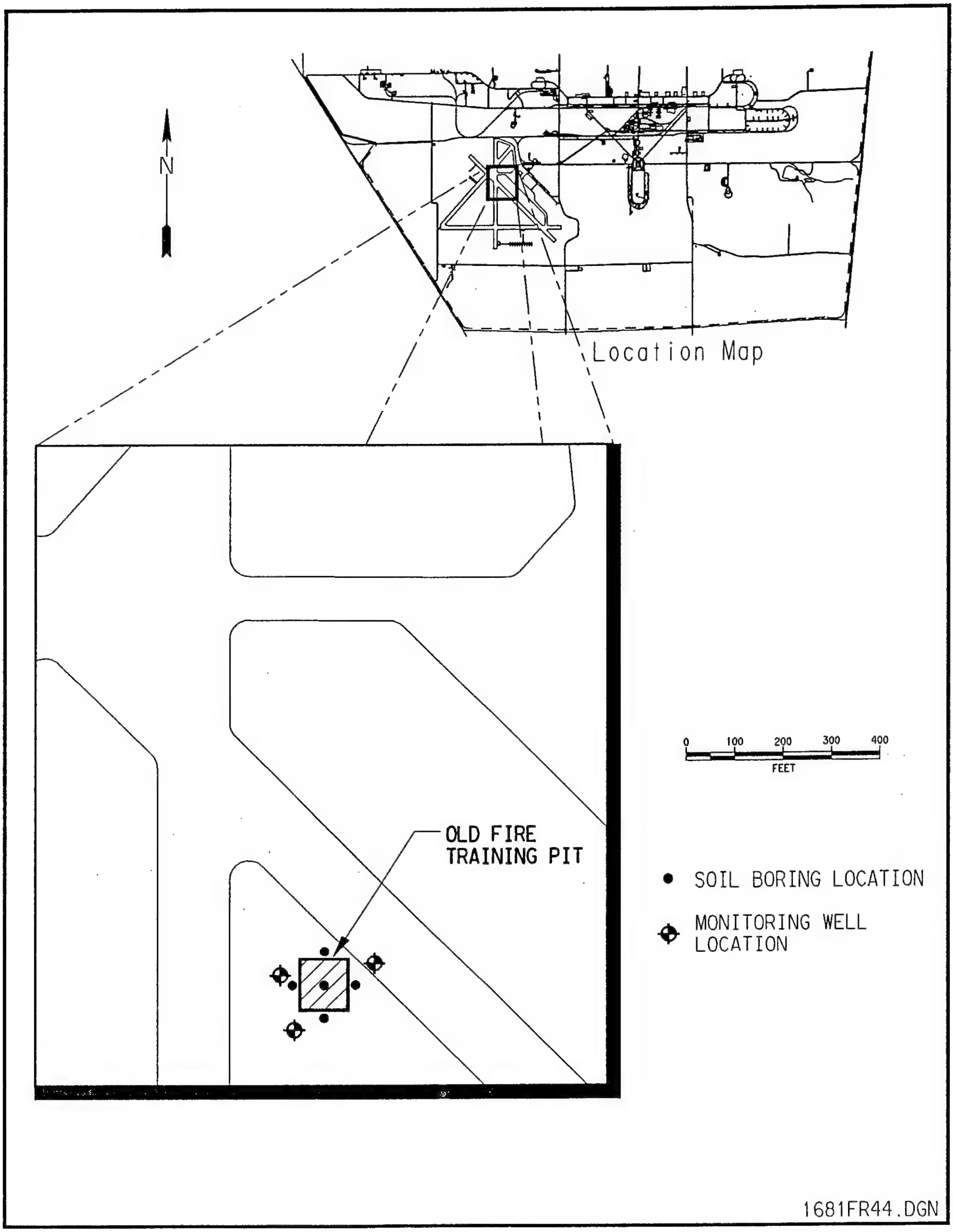

Figure 14. Proposed Sampling Locations at Old Fire Training Pit

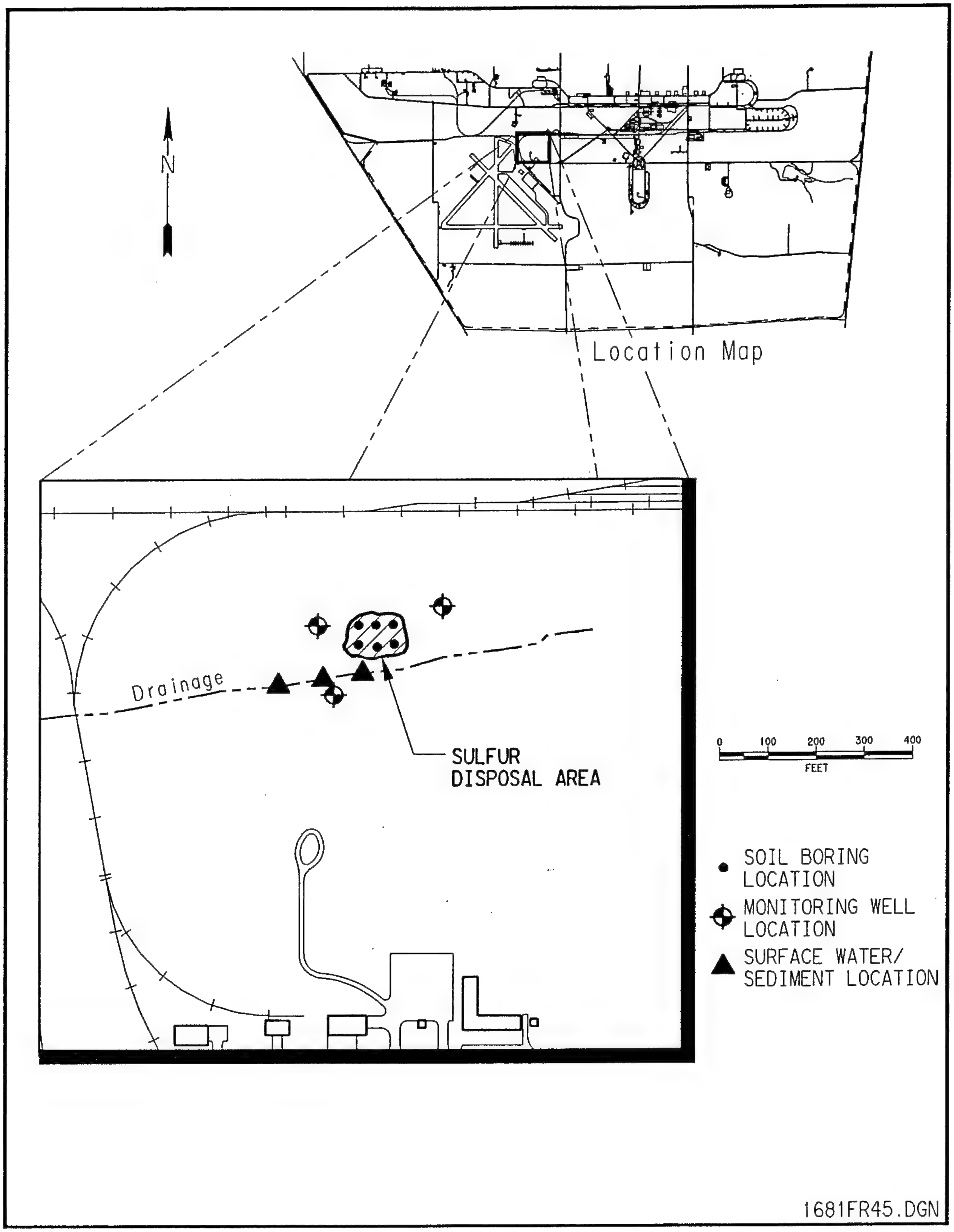

Figure 15. Proposed Sampling Locations at Yellow Sulfur Disposal Area

immersing the bottle with the mouth of it pointing upstream until it is full. These samples will also be analyzed for sulfur, total metals, inorganics (non-metal), and VOCs. Measurement for pH, conductivity, and temperature will be taken in the field at the time of sample collection.

4.13.3 *Soil Borings and Sampling*

A grid will be established across the sulfur-disposal area with a grid spacing of 20 feet. Six soil borings will be drilled from the surface to a depth of 10 ft. Soil samples will be collected using a stainless-steel split-barrel sampler at depths of 0 to 1 foot, 4 to 5 feet, and 9 to 10 feet. Samples will be analyzed for sulfur, total metals, and inorganics. In addition, the soil cores will be scanned with a PID and, if VOCs are detected, biased samples will be collected for VOC analysis.

4.13.4 *Unexploded Ordnance Screening*

Since the disposal site may have been a landfill area for other types of materials, UXO personnel will survey each boring location for UXO and will monitor the borings at 5 feet for buried metal to ensure the safety of the drilling and sampling crew.

4.13.5 *Monitoring Well Installation and Sampling*

If analytical results from subsurface-soil samples indicate that contaminants are migrating from the sulfur-disposal area to the groundwater pathway, one upgradient monitoring well and two downgradient monitoring wells will be installed and sampled (see Figure 15). Well installations will be in accordance with USATHAMA geotechnical requirements (Appendix B) and will be sampled according to procedures presented in Appendix A. Groundwater samples will be analyzed only for the contaminants of concern as determined from the results of subsurface soil sampling and analysis. Water-quality parameters (i.e., pH, conductivity, and temperature) will also be taken at the time of sample collection. This is particularly important at this site since the presence of sulfur in groundwater often results in highly acidic conditions ($pH \leq 2$).

4.14 Burn Area South of New Incinerator

4.14.1 *Surface Soil Sampling*

Four near-surface soil samples will be collected around the perimeter of the concrete pad to a depth of 0 to 1 foot. The samples will be analyzed for explosives, metals, and TPH (see Figure 16).

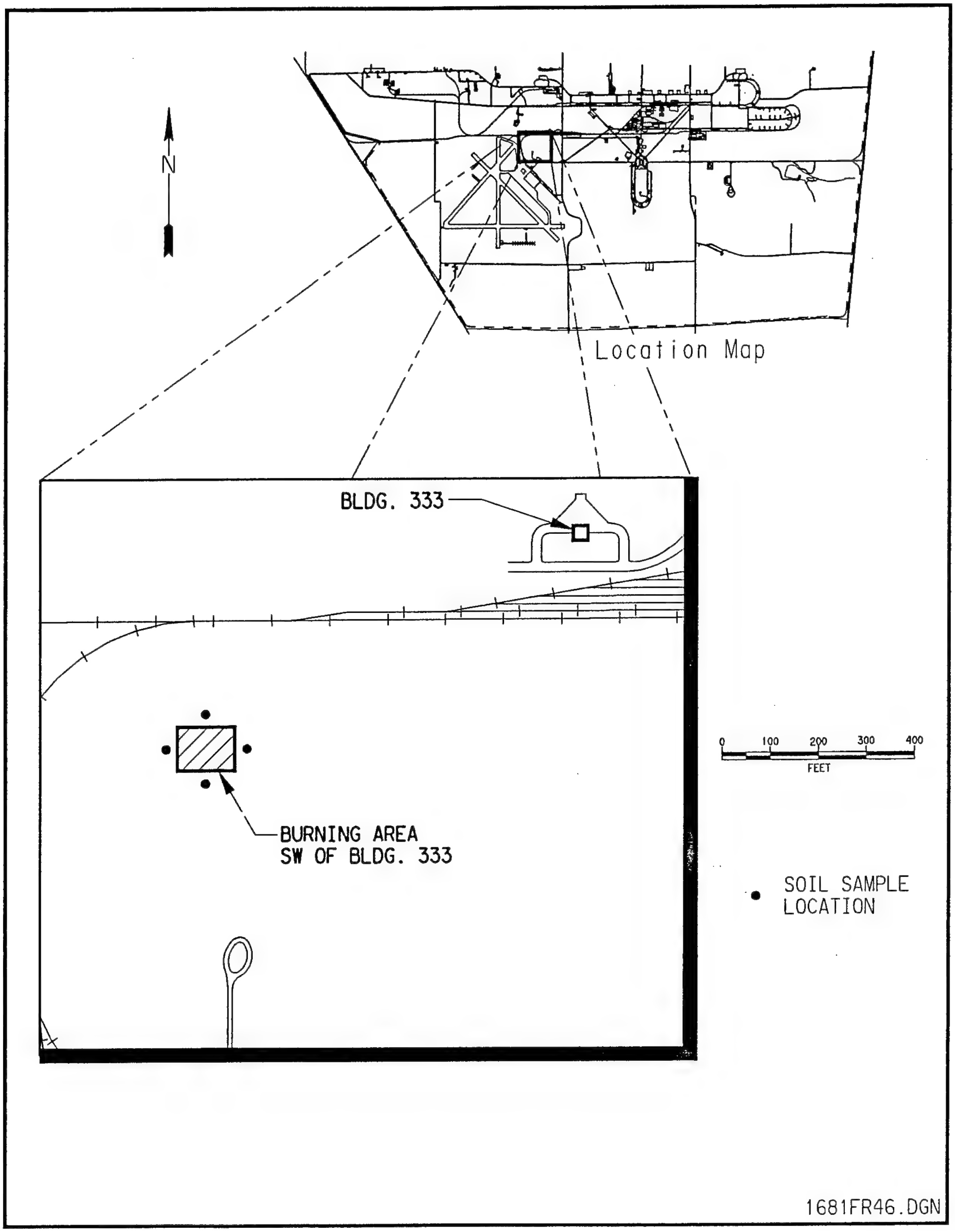

Figure 16. Proposed Sampling Locations at Burning Area SW of Building 333

4.14.2 *Wipe Samples*

One wipe sample will be collected from the center of the concrete pad and analyzed for explosives, metals, and TPH.

4.15 Potential Ammo Dump Site

4.15.1 *UXO Surveys*

Prior to start of any other activities, an initial surface UXO survey will be made of the potential dump sites (see Figure 17).

If no surface UXO is encountered and subsequent geophysical surveys locate the dump site, additional UXO surveys will be accomplished by excavating test pits for the purpose of identifying the contents of the dump site.

4.15.2 *Geophysical Surveys*

Magnetometer and GPR surveys will be conducted using a 50-foot grid spacing over the suspected dump site.

If anomalies are present, a closer spaced survey will be conducted to determine the exact location and estimated depth of the disposal site.

4.15.3 *Test Pits*

If the site can be properly located, two test pits will be carefully dug using an experienced backhoe operator and a qualified UXO team. UXO scans will be conducted at every 1-foot interval as the test pit is deepened. Any items uncovered during the operation will be inspected by UXO support personnel for identification and evaluation of condition. Disposal will be the responsibility of JPG personnel.

4.16 Asbestos-Containing Materials

4.16.1 *Suspected-Asbestos-Materials Sampling*

On the basis of building surveys, all materials suspected to contain asbestos, but not previously confirmed, will be collected and sent to the laboratory for analysis and identification.

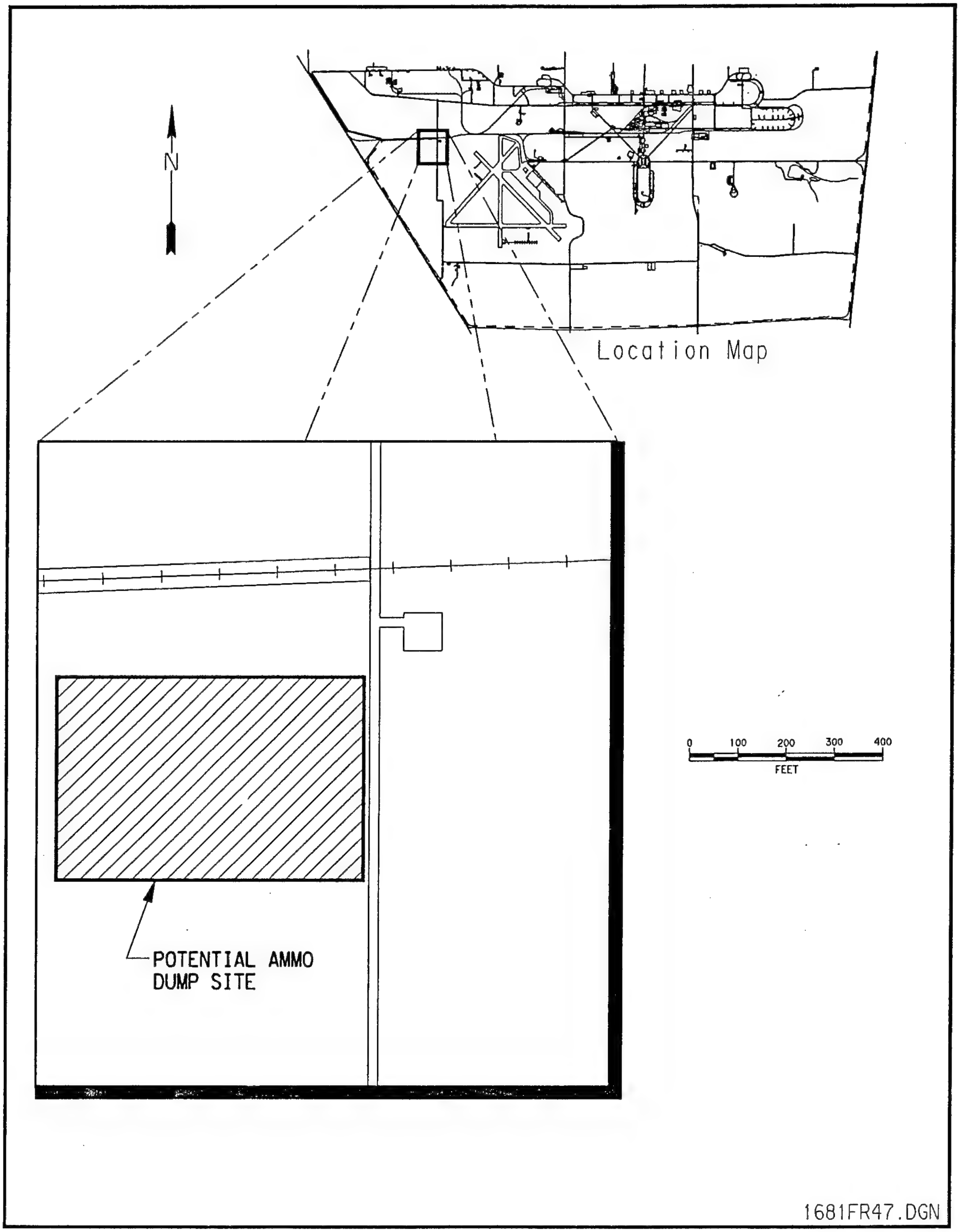

Figure 17. Approximate Location of the Potential Dump Site

4.17 Underground Storage Tanks

4.17.1 *Subsurface-Soil Sampling*

Following a review of all previous UST leak-testing results and previous soil-sampling results, those USTs where releases of contaminants to the environment are known or suspected to have occurred will be characterized for contaminant release by subsurface-soil sampling and analysis.

At each UST location, four borings will be drilled around the perimeter of the tank or former tank site. These borings will be drilled to a depth of 10 feet with a hollow-stem auger rig, and samples will be collected using a stainless-steel split-barrel sampler. Samples will be collected from 3-to-4-foot, 5-to-6-foot, 7-to-8-foot, and 9-to-10-foot intervals, resulting in an estimated 16 samples per UST location. The samples will be analyzed for TPH and benzene, toluene, ethylbenzene, and xylene (BTEX).

4.18 Off-Site Water Supply Wells

4.18.1 *Soil Borings and Sampling*

Two soil borings will be drilled, one near each UST (see Figure 18). Six subsurface samples will be taken to determine if contamination exists. These samples will be analyzed for TPH and BTEX.

4.18.2 *Wipe Samples*

Two wipe samples will be collected from stained areas at the former pump sites. These samples will be analyzed for TPH.

4.19 Temporary Waste-Storage Areas (Buildings 279 and 305)

4.19.1 *Soil Borings and Sampling*

Soil borings, soil sampling, and wipe sampling will be performed in accordance with the RCRA Closure Plans for Buildings 279 and 305 (January 1992 and March 1992, respectively). The RI/FS will address only those sampling requirements of the closure plans that investigate the presence of contaminants prior to decontamination or removal activities. The sampling and analytical requirements in the closure plans are subject to modification pending State of Indiana approval of the plans. Samples will be analyzed for TCLP (EPA Method 1311), VOCs, semi-VOCs, and PCBs. Sample analyses will be in accordance with USATHAMA approved methodologies. The plans call for two soil borings inside Building 305 along cracks in the floor and four soil borings outside for background soils data (see Figure 19). Samples are to be collected from the 0-to-2-inch depth, 2-to-12-inch depth, and the 12-to-24-inch depth.

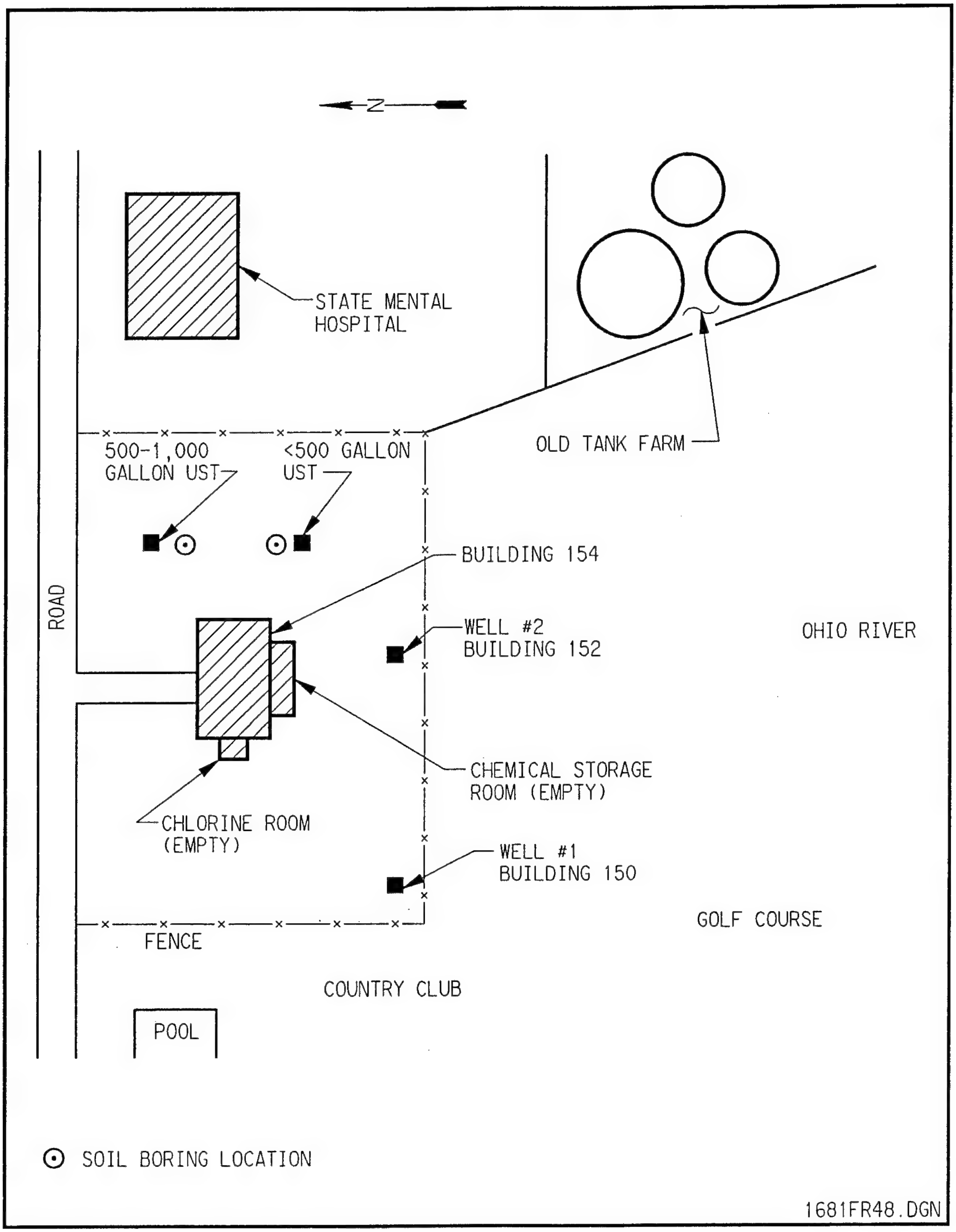

Figure 18. Proposed Sampling Locations at Off-Site Water Supply Wells

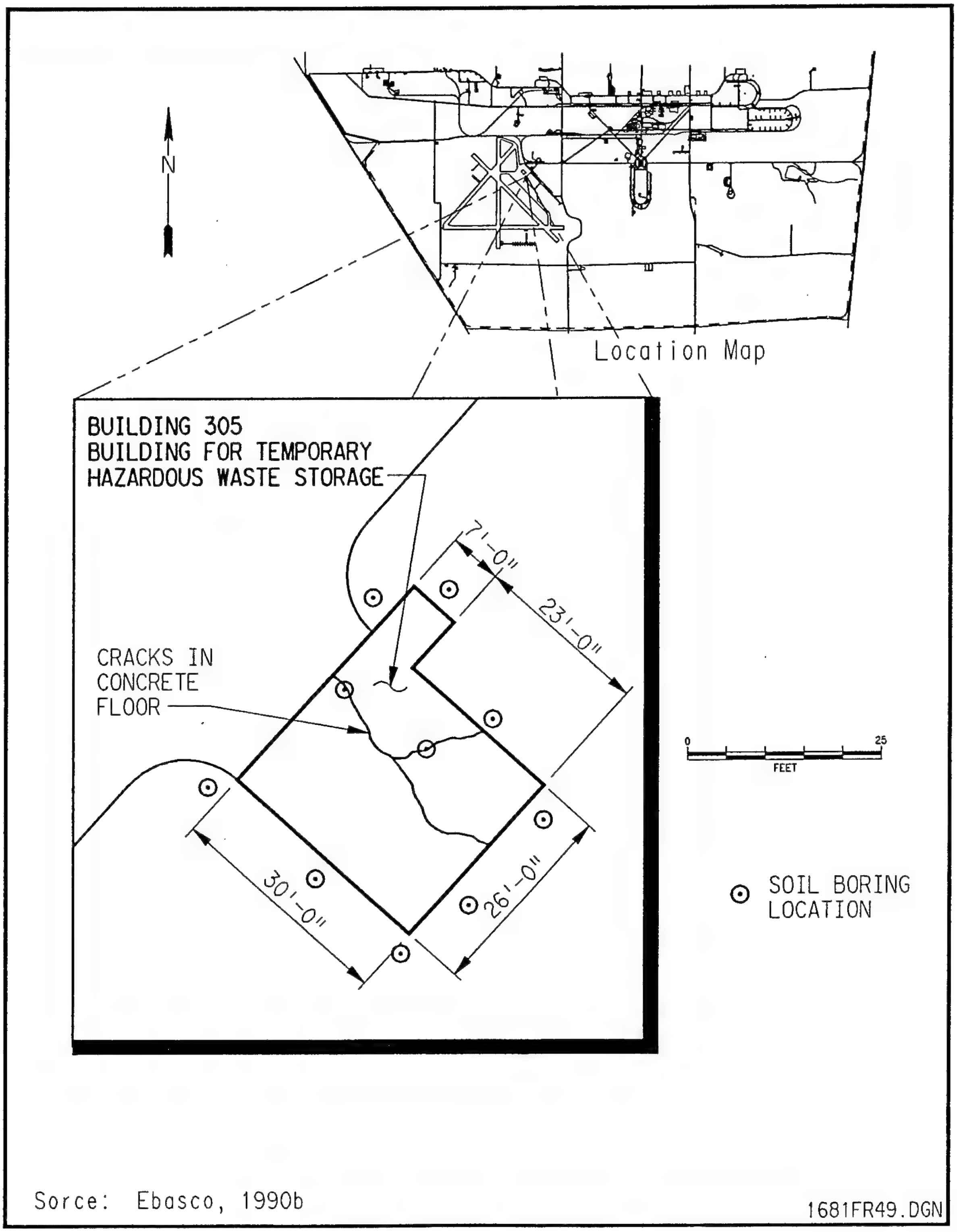

Figure 19. Proposed Sampling Locations at Building 305 Temporary Waste Storage Area

Approximately eight soil borings are proposed for building 279 in addition to the four proposed for the solvent pit investigation (see Figure 20). These borings will be drilled around the perimeter of the building and three samples per boring will be submitted for analysis of TCLP metals, VOCs, semi-VOCs, and PCBs.

4.19.2 *Wipe Samples*

Sixteen wipe samples will be collected from inside each building. Samples will be submitted for analysis of TCLP metals, VOCs, semi-VOCs, and PCBs.

4.20 Temporary Storage Areas (Buildings 105, 186, 204, 211, and 227)

4.20.1 *Soil Borings and Sampling*

Three surface soil samples will be collected from stained areas at buildings 204 and 211 (see Figure 21). If no soil staining is found, then samples should be collected from obvious surface-water pathways. No soil sampling is proposed for Buildings 105, 186, and 227 unless evidence of soil staining is observed.

4.20.2 *Wipe Samples*

Three wipe samples will be collected from any stained areas observed inside Buildings 204 and 211.

4.21 Groundwater System South of the Firing Line

4.21.1 *Contingent Monitoring Wells and Soil Borings*

It is proposed that an additional 10 wells and 10 soil borings be considered for the purpose of filling in data gaps observed during the field investigation and to address the overall characterization of on-site groundwater flow. Nine of the additional wells will be installed as three clusters of three wells each for the purpose of determining vertical-flow gradients. Within each well cluster of three, one well will be screened at the base of the alluvium, one well will be screened in the first water-producing zone in the bedrock, and one well will be screened at a deeper bedrock producing zone not to exceed 100 feet deep. The well clusters will be widely spaced across the southern part of JPG, preferably installed as upgradient wells near groups of sites with one cluster located near the Gate 19 Landfill, another located near the Gator Mine area, and another near the Wastewater Treatment Plant. These wells will be sampled for VOCs, semi-VOCs, metals, and explosives. The soil borings should be drilled at sites where unexpected discoveries require additional characterization, and the samples will be analyzed for contaminants of concern at each site.

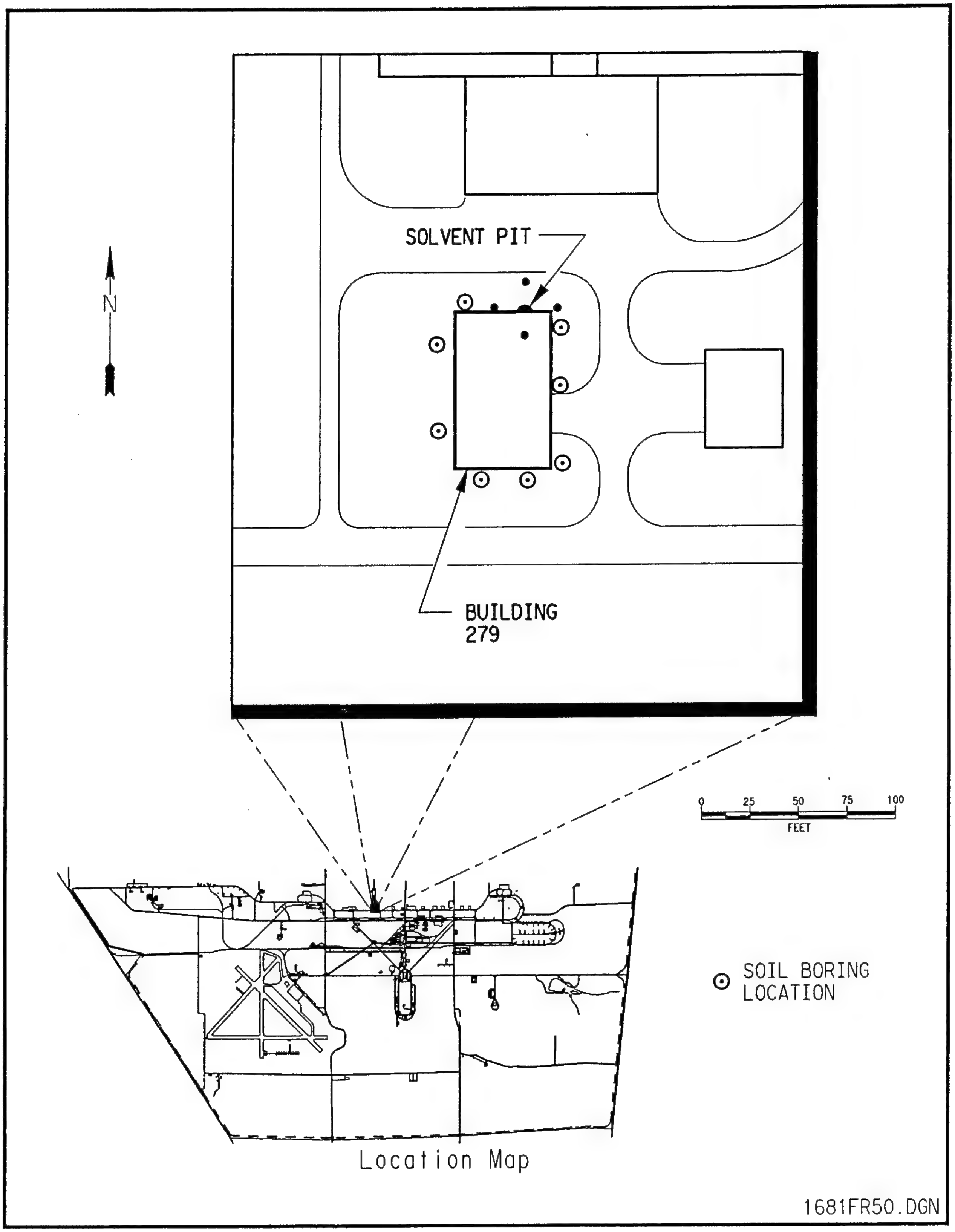

Figure 20. Proposed Sampling Locations at Building 279

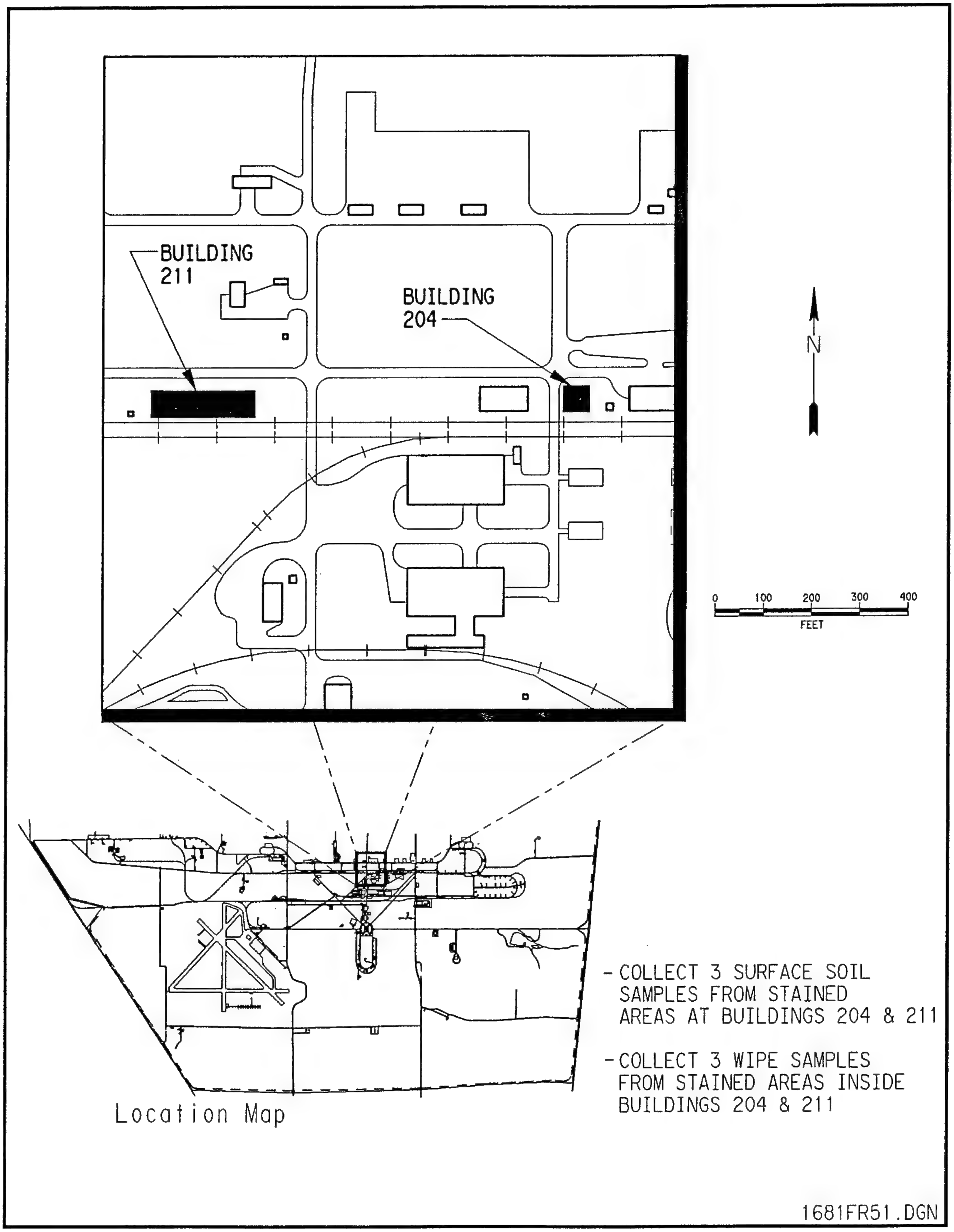

Figure 21. Proposed Sampling at Buildings 204 and 211

5.0 FIELD METHODS

The following section describes the methods for the collection of field measurements and sample data proposed in Section 4.0 and in the procedures to be followed to ensure that only quality data are obtained. It also provides requirements for sample identification, sample-handling, and storage. Field Quality Assurance/Quality Control requirements are briefly discussed, but are presented in more detail in the Quality Control Plan (Volume III). Unusual field sampling conditions may require departure from the procedures described in this plan. Such occurrences will be fully documented in the field logbooks for the affected site(s). All changes will be brought to the attention of a USATHAMA representative for concurrence or approval.

5.1 Unexploded-Ordnance Clearing

Past activities at JPG may have resulted in UXO and/or reactive-soil hazards being present in areas to be studied under the RI/FS. Detailed procedures for UXO clearing for health and safety purposes are presented in the site-specific Health and Safety Plan (Volume IV). For all UXO-clearance activities, personnel will comply with the U.S. Army Series 60 Manual for handling ordnance items and will follow current USATHAMA Safety Office guidance (USATHAMA, 1987). In addition, the following conditions will be met by the Explosive Ordnance Disposal (EOD) subcontractor:

- Standard Operating Procedures will be maintained on-site for all UXO procedures.
- Communication equipment (i.e., radios or cellular telephones) will be available to EOD personnel to allow direct contact with emergency response personnel.
- UXO operations will be conducted only during daylight hours and proper weather conditions (activities should not be conducted during severe weather conditions such as lightning storms).
- A minimum of two EOD personnel will be present at all times during UXO surveys.
- EOD personnel clear all work crews from the area upon locating UXO, will notify appropriate installation personnel of any UXO encountered, and will arrange for safe rendering and disposing of UXO prior to any further work being conducted at the affected site. Any such rendering and disposal activity must be approved by the USATHAMA Health and Safety Branch.
- A visual walkover UXO scan will be completed in areas where geophysical surveys are to be conducted.
- UXO support will be provided for any drilling or trenching in areas where buried trenches, pits, or landfills are suspected. This will involve subsurface scans for UXO. Any encountered ordnance will result in the abandonment of the boring or trench. EOD personnel will provide site security until a decision can be made on the disposition of the ordnance by installation personnel.

The subcontractor will maintain a logbook of all UXO-survey operations and results and will prepare a final report at the completion of activities that summarizes all findings including the location of all UXO encountered whether determined safe or hazardous. Any surface UXO will be left in place, but will be clearly marked with a fluorescent pin flag, and the location will be plotted on a sketch map for installation identification, assessment, and disposal.

5.2 Geophysical Surveys

Geophysical surveys will be conducted at JPG to locate former areas of landfills, trenches, or pits used for burning or disposal that have since been covered and, in many cases, revegetated. The geophysical technique(s) to be used at each site will be dependent on site conditions. The recommended surveys are magnetometry and GPR, although other techniques may be considered. The magnetometer survey will be conducted at each location first to allow detection of buried materials which, in turn, will allow focus of specific areas for GPR, thereby allowing better definition of trench, pit or landfill boundaries.

5.2.1 *Magnetometry*

Magnetometry is routinely used to locate buried metal objects such as tanks, drums, scrap metal, etc. Magnetic instrumentation measures small perturbations in the earth's magnetic field produced by local geologic and cultural features.

A Vertical Magnetic Gradiometer is recommended for initial surveys. A typical gradiometer is a proton-precession magnetometer with two sensors mounted from 0.5 to 1.0 meter apart on a staff, which is held vertically while a measurement is taken. Total magnetic-field values are taken simultaneously on both sensors, and the difference of the values between the sensors divided by the distance between them is the vertical-gradient value. Vertical-gradient data are more sensitive to the presence of ferrous-metallic debris than total magnetic-field data alone.

Grid systems will be laid out for each area to be surveyed using a measuring tape and line-of-site between grid stakes that will be initially established around the perimeter of the survey area (typically, every 100 ft). Pin flags or small stakes will be placed between the initial perimeter stakes on an established spacing that is appropriate for each site (typically, 10 or 20 feet). The survey grid will be tied to a known coordinate system (i.e., State Planar, UTM, or JPG coordinate systems).

5.2.2 *Ground Penetrating Radar*

GPR will be performed utilizing the previously established magnetometer grid if additional definition of trench, pit, or landfill boundaries are required. GPR uses electromagnetic waves in the frequency range of 80 to 1,000 megahertz to define subsurface stratigraphy. With the GPR technique, electromagnetic energy is radiated into the subsurface from an antenna that is pulled slowly across the ground by hand at speeds varying from about 0.25 to 5 miles per hour, depending on the amount of detail desired and the nature of the target. The radio wave energy is reflected from surfaces where there is a contrast in electrical

properties of subsurface materials. These surfaces may be naturally occurring geologic horizons or manmade. The reflected energy is processed and displayed as a continuous strip-chart recording of distance versus time, where time is approximately proportional to depth. For areas where material was removed (i.e., trenches) and subsequently refilled with contrasting material, GPR can accurately determine the boundaries of the area due to the contrast in reflected energy.

The same grid system will be utilized for the GPR survey, although the spacing within the grid may vary according to site conditions.

5.3 Monitoring Well Installation

Monitoring wells will be installed as part of this RI to determine if the groundwater pathway has been impacted by a contaminant release. Drilling will be performed by a qualified drilling contractor familiar with USATHAMA geotechnical requirements and State of Indiana regulations governing drilling and abandonment.

5.3.1 *Drilling*

Hollow-stem auguring will be conducted to advance the borehole to bedrock. Once bedrock has been reached, mud-rotary drilling will be used to drill the hole to total depth. The mud used for the drilling will be made using approved water and pure Wyoming bentonite. The resulting cuttings and mud will be directed to a mud tank, where the drilling fluids will be screened and the cuttings removed.

A boring log, which will contain all of the information required by USATHAMA (see Appendix B), will be maintained for each borehole as it is drilled. These logs will be provided to USATHAMA at the completion of drilling, and the resulting data will be entered into the IRDMIS data base (i.e, map files). Figure 22 is an example of a boring log used to record the required information.

5.3.2 *Well Installation*

Well installation will begin within 48 hours of boring completion and will continue until completion without interruption.

Well casing and screen will be 4-inch, Schedule 40, threaded PVC. No PVC solvents will be allowed. All screens will be 10 feet in length with a slot of 0.010 inch and a threaded bottom cap or plug. All well screen and casing materials will be steam cleaned prior to installation in the borehole. A solid riser above the screened interval will extend to approximately 2.5 feet above the ground surface. A sand pack, approved by USATHAMA,

Boring Log

Project Site____

Site ID __________________ Auger Size____________________

Date/Time Started _______________ Date/Time Completed_____________

Surface Elevation (optional) ____________ Water Level (from GroundSurface) _____________

Completion Depth ________ Drilling Co.____________ Driller____________

Drilling Type __________ Sample Type _________ No. of Samples__________

Geologist/Logger & Co. ______________________________________

Figure 22. Boring Log

BORING LOG GENERAL DATA

Project:	Boring:	Page: 1 of
Driller & Company:		
Geologist/Logger & Company:	Signature:	
Date Boring Started:	Completed:	
Water Levels (From Ground Surface)	Drilling Rig:	
First Encountered:	Date:	
While Drilling:	Date:	
At Boring Completion:	Date:	

Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End

Abbreviations:

Abbr Meaning

Location Sketch:

Figure 22. Boring Log (continued)

Project:			Boring:		Page: of
Depth/ Eval.	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample No. & Depth	Blow Count & Recovery	Drilling Data

Figure 22. Boring Log (continued)

will be installed around the well screen to 5 feet above the well screen. A 5-foot-thick bentonite seal will then be placed above the sand pack using USATHAMA-approved bentonite pellets. After the seal is allowed to hydrate 1 to 2 hours, cement-bentonite grout will be applied to the ground surface. The grout will consist of 20 parts Type II or Type V Portland Cement to 1 part bentonite with a maximum of 8 gallons of approved water per 94-pound bag of cement. These proportions may be modified with USATHAMA approval if field conditions dictate. An 8-inch ID protective casing will be installed over each well. This casing will extend approximately 2.5 feet above ground surface (i.e., 0.2 foot above the top of the PVC casing) and will be seated 2.5 feet into the ground. It will be cemented in place. This casing will have a hinged and lockable cap. The locks will all be keyed the same with at least five copies provided to JPG personnel at project completion. After the installation is complete, a mortar collar will be installed between the well casing and protective casing, and a 1/4-inch-diameter drain hole will be installed in the protective casing immediately above the mortar collar near the ground surface. Four iron/steel protective guard posts with a diameter equal to or greater than 3 inches will be installed around the well and painted with high visibility orange paint. At that time, the monitoring well will be properly labelled using a welder and white paint to permanently mark the well number on the protective casing.

5.3.3 *Well Development*

Initial well development will begin no sooner than 48 hours, but no later than 7 days, following well installation. Field data collected during well development will be submitted to USATHAMA within 3 working days after well development.

Development of the wells will be accomplished with an electric-powered submersible pump and/or bailer. All development equipment/materials will be steam-cleaned prior to use at each well location. Pumping of the well will continue until the water is clear to the unaided eye and the well is free of sediment (i.e., less than 1 percent of the screen length), and the total volume of water removed from the well is at least 5 times the standing water volume in the well (i.e., assuming 30 percent porosity within the sand pack). A sample of the last water obtained from the development process will be retained as required by USATHAMA.

A well development record will be maintained containing all of the pertinent information required (i.e., date; static-water level before and after development; quantity of standing water prior to development; water-quality parameters before, during (at least 3 times), and after development; total well depth; screen length; equipment used; quantity of water removed, etc.). An example of a well development log is shown in Figure 23.

5.4 Sample Collection

5.4.1 *Sample Identification*

Each sample will be assigned a unique identification number that will be easily identifiable as to the project (JPG), site number (i.e., 015 = Gate 19 Landfill), sample media type (i.e.,

Well Development Record

Project: TEAD - South Area

Geologist: J C Brown

Well No.: 135 87 91

Date of Installation: 5-14-91

Well Information

Total Depth: 15.42

Casing Stickup (PVC): Flush

Screen Length:

Amt. of fluid in well (Prior to development)

In well casing: 3.64

In sat. annulus:

(30% porosity)

Amt. of mud/water lost

During drilling:

During fluid purging:

Development

Date/time started: 5-17-91 14:15

Completed: 5-17-91 1600

Water level

Before development: 11.78

24 hrs. after:

Depth to sediment

Before development: None

After development: None

Measurement	pH	Specific Conduct.	Date	Time	Vol. Wtr. Removed
Before Development 1	7.3	1700	5-17-91	1415	1 gal
2	7.18	1400			1430	10
3	7.30	1400			1440	22
4	7.37	1400			1453	35
5	7.32	1400			1500	50
After development					

Surge technique: Bailer

Type, size and capacity of bailer or pump: 3" X 3' PVC Bailer

Physical character of water removed (clarity, color, odor, particulates, etc.)

Milky, No odor or Coarse-grained sediment

Quantity of fluid removed:

Time for removal:

Note: all depths measured from top of casing

SOUTH TOOELE RFI PHASE II – FIELD OPERATING PROCEDURES

EXHIBIT 4–2

Figure 23. Well Development Record

GW = groundwater), and location. For example, JPG-015-GW-01 would be assigned to the sample collected from monitoring well MW-1 at the Gate 19 Landfill.

5.4.2 *Sample Requirements*

The laboratory requirements for sample containers, preservation, and holding times for each media sampled as presented in USATHAMA PAM 11-41, Rev. 0, Table H-1 are listed in Appendix A, page A-29.

5.4.3 *Sample Handling, Storage, and Shipping*

All containers used will be pre-cleaned and obtained from a USATHAMA- and EPA-approved supplier. Containers will be visually inspected for integrity and cleanliness prior to use. Suspect containers will not be used and will be labeled "Do Not Use" or will be discarded.

Sample bottles for liquid inorganic analyses will be filled to approximately 90 percent of capacity to allow for expansion of the contents. Sample bottles for organic analyses will be filled with minimum headspace. The 40-milliliter vials used for volatile organic analysis will be filled with no headspace or bubbles.

Sample preservation will be performed immediately upon collection. For acidified samples, pH will be checked to ensure proper preservation. Ice chests will be used to cool samples during the sampling event and will also be used for shipping to the laboratory. A refrigerator will be obtained for storing samples that cannot be shipped via overnight delivery. This refrigerator will be kept in a locked room or, at a minimum, will have chain-of-custody seals placed on the door to ensure sample custody is maintained.

Those samples that have background-to-low levels of contaminants will be handled, packaged, and shipped as environmental samples. Those samples that contain high concentrations of contaminants on the basis of field-screening methods, will be handled, packaged, and shipped according to the regulations issued by the U.S. Department of Transportation (DOT), 49 CFR 171 through 178, and EPA sampling, packaging, and shipping methods 40 CFR 260.

All samples will be packaged and shipped in a manner that will protect the integrity of the sample as well as protect against any detrimental effects from possible leakage. Packaging and shipping will include placing the container in a zip-lock type bag, packaging in bubble wrap or foam socks, and packing with vermiculite. Shipping containers will be sealed with reinforced tape and will be properly labeled according to Department of Transportation (DOT) guidelines.

Each shipment of samples will be accompanied by a signed chain-of-custody form that specifies the analyses required for each sample and any unique handling requirements based on information obtained in the field.

5.4.4 *Surface Soil and Sediment Sampling*

Prior to sampling, the immediate area to be sampled will be cleared of debris or litter. Where warranted, a UXO sweep will be conducted.

For soil and sediment samples to be collected at depths of 0 to 6 inches, hand operated stainless-steel trowels or scoops will be utilized. Samples for VOC analysis will be collected "as-is" and placed immediately into the sample container to prevent volatile loss. All other material will be placed in a stainless-steel or glass sampling pan (e.g., a cake pan) where the material will be thoroughly mixed with a stainless-steel spoon prior to bottling. Where appropriate, the soil will be scanned immediately following removal using a PID to aid in decisions concerning sample packaging, handling, and shipping. All sampling equipment will be decontaminated following procedures outlined in Section 5.7.

For near-surface soil samples to be collected from depths up to 2 feet (i.e., a soil cover placed over landfills, trenches, pits, etc.), a hand-operated, stainless-steel barrel auger may be used. The sampling equipment will consist of a stainless-steel auger bit attached to a rod and "T" handle. These devices are capable of sampling to depths on the order of 12 feet under some sampling conditions. The auger bit is used to bore a hole to the desired depth and is then withdrawn with the sample material contained within the barrel.

Using a stainless-steel spoon and/or knife, the sample will be removed from the auger barrel and will be placed in a stainless-steel tray for thorough mixing prior to bottling. Samples for VOC analysis, however, will be collected directly from the auger barrel immediately upon removal to avoid loss of volatiles. Where appropriate, the sample will be scanned with a PID immediately following removal. This measurement will aid in decisions concerning sample packaging, handling, shipping, and personnel protection.

Following sample collection, all sampling equipment will be decontaminated according to procedures defined in Section 5.7.

5.4.5 *Subsurface Soil Sampling*

A truck-mounted hollow-stem auger rig will be employed at JPG to complete the subsurface soil sampling. Details of drilling procedures are described in Appendix A.

The hollow-stem auger rig will be used to auger to the desired sampling depth(s). A 2-inch outside diameter by 24-inch-long split-barrel sampler will be used. The sampler will be lowered to the top of the interval to be sampled. Using a 140-pound drop hammer or hydraulic driver, the sampler will be driven for the length of the sampler or until no further penetration is achieved after 50 blows for each 6 inches of penetration.

Once the sampler is full or no further penetration is possible, the sampler will be carefully removed from the borehole and separated from the drive-rod assembly. The sampler will be laid flat on an uncontaminated surface, and the head and drive shoe removed. One-half of

the split-barrel will be removed exposing the sample. The uppermost portion of the sample (i.e, the slough) will be discarded. The sample will be screened with a photoionization detector while in the split-barrel sampler. Sample material to be analyzed for volatile organic compounds will be removed immediately from the core. The remaining sample material will be placed in a stainless-steel mixing pan and will be thoroughly mixed prior to bottling. If a discrete section of the core shows evidence of significant contamination, this section will be sampled without mixing the entire sample core. These samples will be noted in the borehole log or field logbook as being a biased sample.

Following each sample collection, the split-barrel sampler will be steam cleaned or replaced with a precleaned barrel to avoid cross-contamination of the samples or the boring.

All discarded sample materials and drill cuttings will be placed in 55-gallon drums for proper analysis and disposal (see Section 5.8).

For soil borings, a boring log will be maintained that provides at record of lithology, blow counts, and sample depths. These boring logs will be completed according to USATHAMA geotechnical requirements (Appendix B).

5.4.6 *Groundwater Sampling*

Groundwater sampling will occur after monitoring wells have been installed and developed according to the USATHAMA Geotechnical Requirements (Appendix B). Because drilling and well construction disturb the natural groundwater system, a minimum of 2 weeks will be allowed between well development and sampling.

All equipment used for purging, measuring, and sampling will be cleaned before use in each well to prevent cross contamination between wells. Equipment that is dedicated to a well site may not require cleaning between sampling events. Water used for field cleaning of equipment will be from an approved USATHAMA source (i.e., the source will have been sampled and analyzed for contaminants prior to use).

Calibration of sampling equipment will be performed in accordance with the manufacturer's suggested procedures and will be completed prior to each day's sampling activities or more often as required. Records of these calibrations will be maintained for each instrument.

Purging. Immediately following removal of the cap for each well, the breathing zone will be checked with a PID to determine ambient air quality and to determine the required personal-protective equipment required.

The static-water level will be measured using an electronic water-level sounder or interface probe to the nearest 0.01 foot. After the measurement is made and properly recorded, the equipment will be rinsed with clean potable water and distilled water.

The volume to be purged will be calculated on the basis of the total well volume, volume of water in the well annulus, and estimated porosity of the sandpack around the well screen. Five well volumes will be calculated for each well prior to the start of purging.

A submersible pump will be lowered to just below the top of the water column and purging will begin. The pH, temperature, and conductivity of the discharge water will be monitored during pumping. The probes will be immersed in a flow-through cell soon after pumping begins. The standard solutions for calibrating the pH meter will be brought to the temperature of the water in the flow-through bath, and the meter will be standardized prior to taking the pH measurements. Electrical conductivity will be measured using a conductivity meter that has been calibrated before sampling. The conductivity probe will be placed in the flow-through bath; pH, temperature, and conductivity measurements will be recorded periodically throughout the time of pumping. The samples will be collected after five bore volumes have been purged.

All purged water will be containerized pending receipt of laboratory analysis for proper disposal (see Section 5.8)

Sampling. Sample containers will be filled by allowing pump or bailer discharge to flow gently down the side of the bottle with minimal entry turbulence. All sample vials or bottles will be triple rinsed with sample water prior to collection. Where filtration is required, the collected sample will be placed in a clean bottle and passed through a properly prepared filtration apparatus (typically, a 0.45-micron cellulose-acetate or nitrate membrane filters in a filter holder with Teflon support screens on the top and bottom of the filter). When sampling from a pump, the filter apparatus can be placed in-line prior to sample collection.

Preservatives, as described in Appendix A, page A-29, will be added prior to capping the bottles. Measurements of pH, in the case of acidified samples, will be made immediately upon addition of the preservative.

All purging and sampling equipment will be decontaminated following procedures outlined in Section 5.7.

Well-sampling data will be recorded on a groundwater sample collection form that provides a record of all water-level measurements, purging, water-quality parameter measurements, samples collected, preservatives used, and any other pertinent information.

5.4.7 *Surface Water*

Samples of surface water will be collected by immersing the sample bottle(s) in the surface water body. The bottles will be triple rinsed with the water to be sampled prior to sample collection. The water will be collected from a portion of the water body that is well mixed and representative of the water body. For VOC samples, the bottle will be capped beneath

the surface of the water to avoid the trapping of air bubbles. The VOC vial will be inspected for air bubbles following capping. The sampling procedure will be repeated until a sample that is free of bubbles is obtained.

Measurements of temperature, pH, and conductivity will be made at the time of sample collection and will be recorded on the appropriate sample-collection form. These measurements will be taken directly from the surface water body at the time of sampling.

5.4.8 *Drummed-Waste Sampling*

A stainless-steel 2-inch-diameter hand coring device will be used to collect samples for VOCs and all other analyses. The coring device will be forced into the approximate center of the barrel to the full length of the corer. Upon removal from the barrel, the core will be removed using a stainless-steel knife or spoon and will be placed in a stainless-steel pan for compositing (i.e., except for the sample for VOCs, which will be taken directly from the coring device prior to mixing).

5.5 Aquifer Tests

Single-well aquifer tests will be performed on all newly installed groundwater monitoring wells at JPG to measure the hydraulic conductivity of the upper aquifer. The slug-withdrawal method will be used. The slug-withdrawal test apparatus will consist of a capped, weighted bailer and an electronic pressure transducer connected to an automatic electronic data logger. Both the transducer and the bailer are lowered into the well. The bailer support line and transducer cable will be marked to allow proper positioning within the well.

The transducer is lowered to a position 6 inches above the bottom of the well casing, and the cable is taped to the exterior of the casing at the top of the well. The bailer is lowered until the top of the bailer is 6 inches below the fluid level. The data logger is turned on and observed until the water level in the well stabilizes (i.e., until the data logger reading is constant). The recording interval is then set at "continuous" and the bailer is quickly lifted out of the fluid.

Continuous recording is maintained for the first 5 minutes of the test. At 5 minutes, the recording interval is set to 30 seconds; at 10 minutes, the recording interval is set to 1 minute; at 20 minutes, the recording interval is set to 2 minutes; and at 40 minutes, the recording interval is set to 5 minutes. The maximum recording interval of 10 minutes is set at 2 hours into the test and maintained until the water-level recovery rate becomes negligible.

The data from the slug tests will be entered into individual data files on a microcomputer. The first column of the data file will be "time in seconds," and the second column will be "hydraulic head in feet." From this information, as well as from well-completion data (i.e., borehole radius and casing radius), the hydraulic conductivity will be calculated. Plots of the log of the normalized drawdown versus time will be plotted for each well.

5.6 Topographic Survey

A topographic survey will be conducted at JPG to accomplish the following objectives:

- Determination of map coordinates and elevations of each new and existing monitoring well at JPG.
- Establishment of permanent survey control stations throughout JPG for use in establishing location information for all RI activities at JPG.
- Determination of map coordinates for corner points of sample grids at specific sites at JPG as described in Section 4.0 of this plan.

All map coordinates established by the licensed surveyor will be within an accuracy of +/- 1 foot. Elevations established by the surveyor will be with +/- 0.01 foot. Completion of the well surveys will be completed as soon after well installation as possible in order that correct map data are available in the IRDMIS system to accompany laboratory analytical data.

5.7 Decontamination

To prevent cross-contamination, all downhole drilling equipments, monitoring well materials, and sampling equipment will be decontaminated prior to use and between use. Decontamination method requirements will vary according to the location and size of the equipment.

NOTE: USATHAMA requirements forbid the use of detergents or solvents unless special approval is received (i.e., materials contaminated with oil and grease may require a variance from these requirements).

5.7.1 *Drilling Equipment*

Drilling equipment will be steam cleaned prior to arrival at JPG and again upon site arrival at a decontamination pad, which will be constructed during equipment mobilization to the site. This pad will consist of a gently sloping pit, which is lined with an impermeable liner for collection and containerization of decontamination wastes. The driller will supply sufficient material (i.e., auger flights, split-barrel samplers, and bits) to drill more than one boring to eliminate unnecessary down time due to frequent trips to the decontamination pad. For remote sites, a temporary decontamination pad will be constructed at each site.

5.7.2 *Small Sampling Equipment*

For small sampling equipment such as scoops, trowels, spoons, and hand augers, decontamination may be completed using a decontamination station consisting of a plastic ground cover, cleaning pans, brushes, and sprayers. The equipment will first be brushed to remove the majority of visible materials (i.e., residual soil). The equipment will then be placed in a pan of USATHAMA-approved water where the equipment will be washed with

scrub brushes. The equipment will then be moved to a second pan containing approved water for a clean rinse. The last stage will be the spraying of the equipment with distilled water followed by air drying and wrapping in plastic or foil wrap.

5.7.3 *Internally Contaminated Equipment*

During groundwater development, purging, and sampling, the internal portions of hoses and pumps may become contaminated. As with drilling equipment, the external parts may be cleaned using high-pressure steam cleaning. The internal surface of the equipment will be cleaned by first circulating clean water through the system, followed by a second circulation of clean potable water, and then a final circulation of distilled water. This will be accomplished by submerging the pump in the water sources and containerizing the circulated fluids at the other end of the system.

5.7.4 *Sample Containers*

Exterior surfaces of sample bottles will be cleaned prior to packing for transport to the laboratory by wiping the container with a clean paper towel at the sample site and then rinsing (as needed) with USATHAMA-approved or distilled water.

5.8 Waste Storage and Disposal

5.8.1 *Drill Cuttings*

Each boring location will be "diapered" with plastic ground cover and berms to prevent spillage of drilling wastes to the ground surface. The drill cuttings and sample waste will be transferred from the ground cover to 55-gallon drums that will be labeled with the borehole identification (ID), material type, footage contained in each drum, and the date they were drummed. These drums will be placed on pallets for pick-up by the installation or will be hauled to a specified staging or storage area.

Following receipt of laboratory analysis from samples collected from each boring, a determination will be made as to whether the materials in the drums are potentially hazardous. Drums suspected to contain hazardous materials will be sampled, and the sample will be analyzed for the contaminant(s) of concern. If the boring sample data indicate that the cuttings are "clean" (i.e., containing no contaminants exceeding regulatory requirements for classification as hazardous waste), the waste materials will be returned to the site as fill materials. Wastes determined to be hazardous will be appropriately labeled and prepared for disposal by the installation.

5.8.2 *Monitoring-Well Waste Water and Drilling Fluids*

Significant amounts of waste water and drilling fluids are often generated through the process of monitoring-well drilling, development, testing, and sampling. These wastes will either be placed in DOT-approved 55-gallon drums or will be collected in mobile storage tanks

depending on the estimated volumes to be generated. For wells where groundwater samples were found to contain contaminants exceeding federal standards (i.e., drinking water standards), the containerized waste water will be sampled and analyzed for the contaminant(s) of concern. For wells where no contaminants were detected in groundwater samples that exceeded regulatory standards, the water will be discharged to the sanitary sewer system where the water will pass through the installation's waste-water treatment facility. Water considered hazardous waste will be properly labeled and prepared for disposal by JPG.

5.8.3 *Contaminated Refuse*

Personal protective equipment such as coveralls, gloves, and booties, as well as discarded paper towels and other refuse that contacts potentially contaminated materials will be placed in plastic bags, which will be tagged with identification tags that detail the date, location, materials disposed of, and suspected contaminants. These bags will in turn be placed in 55-gallon drums pending receipt of sampling data for the location (i.e., soil samples and groundwater samples). For those sites where no contaminants were found exceeding regulatory standards, the refuse will be taken to an on-site sanitary landfill. Barrels containing materials suspected to have been in contact with contaminants exceeding federal standards will be properly labeled and prepared for disposal by JPG.

6.0 FIELD MANAGEMENT

The following section describes the management activities required to ensure that the project is completed within the allotted time in a cost effective and safe manner, with safety being the highest priority. These activities involve communication, coordination, training, scheduling, and management activities associated with all phases of the field-investigation effort.

6.1 Logistics

6.1.1 *Communication and Coordination*

Coordination of the sampling activities at JPG will be the responsibility of the Project Manager and the Field Team Leader. Contacts will be made through the USATHAMA Project Officer and/or the JPG Environmental Office (EO) Manager to coordinate all field activities in a manner that has minimal impact on installation operations/activities.

The Project Manager or Field Team Leader will be responsible for contacting the appropriate JPG EO personnel prior to the start of work in order to arrange for proper access to all sites and to arrange for EOD support where necessary. Any installation permits required will also be obtained prior to the start of work. The Project Manager will also be responsible for obtaining any state or local permits as required. Badging of field personnel and any on-site training (i.e., safety training) will be conducted as part of the mobilization phase of the

project. The Project Manager will be responsible for arranging these support services through the installation EO.

Contractor personnel will not discuss or provide information to the public or the news media. Any communication outside of JPG will be directed to the USATHAMA Project Officer or appropriate JPG public relations personnel. Communications with outside government agencies will be coordinated through the USATHAMA Project Officer or the appropriate JPG personnel.

An office trailer will be set up at JPG to be used as a contractor command post with telephone and radio service available to handle routine coordination of the project, as well as emergency operations if necessary. Hook-up of this trailer to electrical service will be arranged through the installation or through an outside electrical contractor if installation support is not available.

Daily work assignments will be made by the Field Team Leader, and these assignments and plans will be forwarded to the EO for review and concurrence prior to the start of work to minimize conflicts with installation operations.

6.1.2 *Equipment, Supplies, and Transportation*

All field equipment will be supplied by the contractor (and their subcontractors) conducting the work at JPG. Sampling equipment and supplies will be shipped to the installation or will be acquired locally and will be stored in the field trailer or in an equipment staging area located adjacent to the trailer. Vehicles used for the project will most likely be rental vehicles obtained from a local rental agency. Appliances required such as a refrigerator and freezer will be obtained locally through purchase or lease/rental.
Facilities or containers will be required for the storage and disposal of small quantities of potentially hazardous waste generated during the field-sampling program. Arrangements will be made with JPG for the disposal of these wastes. Arrangements will be made for a decontamination pad area for the washing of equipment (i.e., contaminated drilling equipment). The contractor will provide the necessary materials and storage containers (i.e., 55-gallon drums) for decontamination pad construction and waste collection. If necessary, arrangements will be made to transport drummed or tanked waste to a staging or storage area specified by the installation.

6.1.3 *Field Personnel*

The number of field personnel will vary according to the field activity being performed. Typically, a field crew of 10 people may be on-site at any one time. All field personnel will be fully trained and qualified in the task(s) for which they are assigned. Documentation of these qualifications and training will be maintained by the Project Manager and Field Task Leader. Field personnel will typically work on a 10-day-on-and-4-day-off schedule, with the first and last days restricted for travel.

6.1.4 *Site Access and Control*

All personnel working at JPG will adhere to JPG site access, safety, and emergency requirements. Access to specific areas within JPG is restricted, and personnel will not enter these areas unless prior approval has been obtained and the necessary JPG personnel have been notified of the location and schedule of the work to be performed. As necessary, JPG escorts will be used in restricted areas. All personnel will be required to wear badges for the appropriate identification of contractor personnel by installation security.

Also, certain areas will require the ban of any flame-producing devices or firearms. Other areas will have to have UXO clearance prior to entering the site. All such restrictions will be strictly adhered to by contractor and subcontractor personnel. Health and Safety restrictions are presented in the Health and Safety Plan (Volume IV).

6.1.5 *Sample Shipments*

Due to the short holding times associated with many of the samples collected for laboratory analysis, shipments will be made on a daily basis, using an overnight or priority-mail service. Shipments will be made from a local pick-up location according to the specific carrier's schedule.

6.2 Field Documentation

Documentation and records of all field activities at JPG will be maintained by the Field Team Leader and Project Manager at the field office while field operations are being conducted. The following is a description of the various types of documents which will be maintained and controlled during the field-investigation phase of the RI.

6.2.1 *Document-Control Log*

A log will be maintained in the field office that will document the issue and return of field logbooks. Personnel will sign and date the log at the time a specific logbook is issued to them. When the logbook is completed or the work is completed, the person will sign and date the return. If a logbook is to be transferred to another person, the check-in/check-out procedure will be followed.

6.2.2 *Field Logbooks*

Bound logbooks with consecutively numbered pages will be used by field personnel for each major field task performed. The logbook will be used to record daily activities of the field team, field measurements taken (or refer to field data forms used), provide sketch maps of measurement and sample locations, and to note any observations made (i.e., weather conditions, mechanical problems, or any other items that may affect the quality of the resulting data). Each page will be signed and dated by the person making the entries and

will also be reviewed by an independent person who will review the entries for accuracy, completeness, and clarity. This second person will also sign and date the page following review.

6.2.3 *Daily Drilling Log*

This log will be completed daily by the drilling subcontractor, who will document each day's drilling activities, including a record of boring numbers drilled, boring location, the footage drilled, materials used, standby time, problems encountered, and general observations. The log will also contain the name of all drilling personnel, their title, and their employer. These logs will be reviewed at the end of each day by a qualified contractor drilling supervisor and will be approved by the drilling supervisor as being complete and accurate. Upon completion of the project, these documents will become part of the project evidentiary file, which will be submitted to USATHAMA at project completion.

6.2.4 *Boring Log*

Each boring will have a boring log completed that documents such items as the boring ID and location, the contractor name, type of drilling being performed, the date, lithology encountered, ID number and depth of samples collected, blow counts (where applicable), measurements readings (i.e., PID measurements), and comments. These logs will be completed and submitted according to USATHAMA geotechnical requirements (Appendix B).

6.2.5 *Well-Completion Log*

A well-completion log will be completed for each new well installed at JPG. This will include a sketch of the well installation showing the types, depths, and quantities of materials used in the completion of the well (i.e., blank casing, screen, sand pack, and grout). The sketch will be in sufficient detail to show such items as protective casing, well caps, locks, protective pad, and protective posts. These logs will be provided to USATHAMA according to the delivery schedule defined in the USATHAMA geotechnical requirements (Appendix B).

6.2.6 *Chain-of-Custody Forms*

A copy of each chain-of-custody form will be retained in a file maintained at the project site for traceability in the case of sample loss or delays in shipment. This file will be maintained in the field until completion of sampling activities and will become part of the permanent project file following completion of sample analysis activities. The original form will accompany the sample shipment and will be maintained by the laboratory performing the analysis.

6.2.7 *Project File*

The Project Manager will maintain a project file that will contain all pertinent information gathered in the course of fieldwork. This includes, but is not limited to, completed field-data forms, completed logbooks, instrument calibration records, computer software, training records, permits (i.e., for access, drilling, and excavation), and accident reports.

6.3 Field-Data Management

Data collected during the RI at JPG will initially be in various forms. Portions of the data will be handwritten in field logbooks, some will be in the form of instrument data output (i.e., strip charts), while other data will be transferred directly from instrumentation to a microcomputer data base. The field-office trailer will contain a microcomputer and data-management system that will be used to enter and compile all of the data on a central database. For those files entered into the USATHAMA IRDMIS system, a modem will be installed with linkage to the contractor's computer system that accesses the IRDMIS system. This will allow transfer of field data into the system (i.e., data to be entered into the map file or geotechnical file). Any programs used to correct or reduce field data will undergo a QA verification prior to their use. A hard-copy output of the various completed data files will be placed in the permanent project files.

Hard-copy output will also be reviewed for accuracy and completeness following transfer of handwritten field data to the computer database to ensure that the data were entered correctly by the data entry person. This QA check will be performed on all data transferred manually. For data transferred automatically (i.e., from a field datalogger), the output will be spot checked for completeness and accuracy. An audit of all data will be completed prior to completion of field activities to allow the collection of additional data if previously collected data are found to be in error.

Copies of all data, including interpretative maps and plots, will be maintained in the on-site project file. In addition to data required by USATHAMA, computer modeling may be performed using QA-verified computer programs. This modeling may be used to guide follow-on field activities (i.e., soil-gas-survey contaminant contour plots may assist the proper location of soil borings).

6.4 Field Schedule

The proposed schedule for the completion of field activities at JPG is based on the timely review and approval of the RI/FS planning documents, which include a draft, final draft, and final version, by USATHAMA and the appropriate regulatory agencies (see Table 2).

Table 2. Proposed Schedule for the Completion of Field Activities at JPG

Task	Proposed Schedule
Mobilization	October 26 - 30, 1992
Field Investigations	
UXO Surveys	October 27 - 28, 1992
Geophysical Surveys	October 28 - November 17, 1992
Soil Borings and Sampling	November 2 - January 5, 1993
Surface Water sampling	October 28 - 29, 1992
Monitoring Well Installation,	March 3 - May 11, 1993
Development, Testing and	
Sampling (as required)	March 24 - June 23 1993
Asbestos Survey/Sampling	November 3 - January 4,1993
Land Surveying (as required)	May 19 - 24, 1993
Demobilization	June 24 - 30, 1993

7.0 ANALYTICAL LABORATORY METHODS

The QA/QC objectives of accuracy, precision, completeness, comparability and representativeness are well defined in the USATHAMA Quality Assurance Program Plan (USATHAMA, 1990). The following section briefly describes the laboratory program for ensuring that the objectives be met. More detail is provided in the site-specific Quality Control Plan (Volume III).

7.1 Laboratory Procedures

All laboratory procedures will be checked for accuracy through internal laboratory quality-control checks, such as the running of blind duplicates, splits, and known standards. These checks are described in more detail in the Quality Control Plan (Volume III). Only USATHAMA-certified methods will be used and verification of the laboratories current certification will be made prior to start of the project. Table 3 presents the analytical parameters and USATHAMA methods that will be used for the RI at JPG. Where appropriate, the corresponding EPA methods are referenced for comparison. The subcontract laboratory performing analytical support for the RI at JPG will provide a list of equipment and personnel to be used as well as the certification information required. These lists will be reviewed and approved by the contractor and USATHAMA (as required) prior to the start of work.

7.2 Quality Assurance/Quality Control

The Quality Control Plan (Volume III) describes in detail the laboratory QA/QC requirements for the analysis of samples collected under the RI/FS for JPG. The following provides a description of the general laboratory requirements.

Table 3. Analytical Parameters for JPG

	Semi-Volatile Organic Compounds	LM-25 (soil)/GCMS (EPA Methods 8270, 625) UM-25 (water)/GCMS	
0.032	1,2,3-Trichlorobenzene		5.8
0.22	1,2,4-Trichlorobenzene		2.4
0.042	1,2-Dichlorobenzene		1.2
.05	1,3-Dichlorobenzene-D4		1.4
0.42	1,3-Dichlorobenzene		3.4
.034	1,4-Dichlorobenzene		1.5
1.4	2,4-Dinitrotoluene		5.8
.32	2,6-Dinitrotoluene		6.7
.24	2-Chloronapthalene		2.6
1.3	alpha-Benzenehexachloride		5.3
.0028	alpha-Hexachlorocyclohexane		NL
1.3	Aldrin		13
.041	Acenaphthene		5.8
.033	Acenaphthalene		5.1
0.71	Anthracene		5.2
.36	Bis(2-chloroethyl)ether		.68
.48	Bis(2-ethylhexyl)phthalate		7.7
.041	Benzo[A]anthracene		.041
1.2	Benzo[A]pyrene		14
31	Benzo[B]fluoranthene		10
1.3	beta-Benzenehexachlordie/beta-hexachlorocyclohexane		17
.13	Benzo[K]fluoranthene		10
.032	Chrysene		7.4
.08	Hexachlorobenzene		12
1.8	Hexachloroethane		8.3
.097	p-chlorophenylmethyl sulfide		10
.32	p-chlorophenylmethyl sulfoxide		15
.066	p-chlorophenylmethyl sulfone		5.3
.31	Dibenz[A,H]anthracene		12
.21	delta-Benzenehexachloride/delta-Hexachlorochyclohexane		NL
.060	Diethyl phthalate-D4		8.7
.065	Dithiane		3.3
.079	Dieldrin		26
.23	Di-N-octyl phthalate		1.5
.065	Di-N-octyl phthalate-D4		13
1.3	Endrin		18
.032	Fluoranthene		24
.97	Hexachlorobutadiene		8.7
.24	Heptachlor		38
.48	Heptachlor epoxide		28
2.4	Indeno[1,2,3-C,D]pyrene		21
.10	Lindane		7.2
.18	Malathion		21
.74	Naphthalene		.5
.22	Nitrobenzene-D5		26
1.1	Nitrosodi-N-propylamine		6.8
.075	1,4-Oxathiane		27
.032	Phenanthrene		9.9
.064	2,2-Bis(p-chlorophenyl)-1,1-dichloroethane		18
.068	2,2-Bis(p-chlorophenynl)-1,1-dichloroethene		14
.10	2,2-Bis(p-chlorophenyl)-1,1,1-trichloroethane		18
1.7	Parathion		37
.083	Pyrene		17
	Volatile Organic Compounds	LM23 (soil)/CGMS, UM21 (water)/GCMS	
.20	1,1,1-Trichloroethane		1.0
.33	1,1,2-Trichloroethane		1.0
.27	1,1-Dichloroethylene/1,1-Dichloroethene		1.0
.49	1,1-Dichloroethane		1.0
.50	1,2-Dichloroethane-D4		1.0
.32	1,2-Dichloroethene/1,2-Dichloroethylene		5.0

Soil CRL ug/g	Analytical Parameter	USATHAMA Method/Type	Water CRL ug/L
.20	1,2-Dichlorobenzene		1.0
.32	1,2-Dichloroethane		1.0
	Volatile Organic Compounds (continued)		
.53	1,2-Dichloropropane		1.0
.14	1,3-Dichlorobenzene		1.0
.20	1,3-Dichloropropane		4.8
.20	1,4-Dichlorobenzene		.10
.5	(2-Chloroethoxy)ethene/2-Chloroethylvinyl ether		3.5
.2	Bromodichloromethane		1.0
1.8	Chloroethene/Vinyl Chloride		12
NL	Chloroethene/Vinyl Chloride	Alternate method N8 (water)	1.01
.64	Chloroethane		8
.1	Benzene		1
.31	Carbon tetrachloride		1
2.4	Methylene Chloride-D2		9.7
4.4	Methylene Chloride		10
.96	Chloromethane		1.2
.26	Bromoform		11
.96	Chloroform		1.0
.1	Chlorobenzene		1.0
.25	Dibromochloromethane		1.0
.1	Ethylbenzene-D10		1.0
.19	Ethylbenzene		1.0
.10	Toluene-D8		1.0
.10	Toluene		1.0
.20	1,1,2,2-Tetrachloroethane		1.5
.16	Tetrachloroethylene/Tetrachloroethene		1.0
.23	Trichloroethylene/Trichlooroethene		1.0
.78	Xylenes		1.0
	TCLP Metals	JS-12 (soil)/ICP SIM, SS-12 (water)/ICP SIM	
16.4	Arsenic		117
NL	Arsenic	Alternate Method - AX8 (water)	2.35
3.29	Barium		2.82
1.20	Cadmium		6.78
1.04	Chromium		16.8
20.7	Selenium	SD-23 (water)/GFAA	2.53
.467	Lead	JD-21 (soil)/GFAA (EPA Methods 206-2, 270-2, 272-2) SD-18 (water)/GFAA	4.47
.05	Mercury	Y-9 (soil)/CVAA (EPA Method 245-2), CC-8 (water)/CVAA	.10
.012	Silver	JD-22 (soil)/AA, SD-26 (water)/AA	.333
	Explosives	LW-23 (soil)/HPLC, UW-25 (water)/HPLC	
.922	1,3,5-Trinitrobenzene		.21
.504	1,3-Dinitrobenzene		.458
2.0	2,4,6-Trinitrotoluene/alpha-Trinitrotoluene		.426
2.5	2,4-Dinitrotoluene		.397
2.0	2,6-Dinitrotoluene		.60
2.0	Cyclotetramethylenetetranitramine		.533
1.14	Nitrobenzene		.682
1.28	Cyclonite/Hexahydro-1,3,5-trinitro-1,3,4-triazine		.416
2.11	Nitramine/N-Methyl-N,2,4,6-tetranitroaniline/Tetryl		.631
	Cyanide	KF-15 (soil)/SPEC (EPA Method 335-5), TF-34 (water)/Manual	
5.0	Cyanide		.25
	Anions		
NA	BR	TT09 (water) Chromatography	407

Soil CRL ug/g	Analytical Parameter	USATHAMA Method/Type	Water CRL ug/L
NA	CL		278
NA	F		153
NA	NIT		10
NA	N02		5
NA	N03		10
	Anions (continued)		
NA	P04		NL
NA	S04		175
	Herbicides	LH-18 (soil)/HPLC, UH 10 (water)/HPLC	
.0201	2,4,5-Trichlorophenoxyacetic		.16
.0356	2-(2,4,5-Trichlorophenoxy) Propionic acid		.095
.03	2,4-Dichlorophenoxyacetic acid		.263
NL	Total Petroleum Hydrocarbons	EPA Method 418.1 (No USATHAMA Method)	NL
	Volatile Aromatics	AA9 (soil) EPA Method 8020, AV8 (water) EPA Method 602	
.085	Benzene		1.05
.19	Toluene		1.47
.18	Ethylbenzene		1.37
.26	1,3-Xylene		1.32
.39	1,2 & 1,4-Xylene		1.36
NL	Chlorobenzene		1.39
NL	1,2-Dichlorobenzene		.482
NL	1,3-Dichlorobenzene		.566
NL	1,4-Dichlorobenzene		.579
	Organochlorine Pesticides		
1.4	Aldrin	Soil (LH 17)	.0074
2.8	Alpha-BHC	Water (UH 20)	.0025
7.7	Beta-BHC		.0099
8.5	Delta-BHC		.0034
1.0	Lindane		.0025
68.4	Chlordane		.0312
1.6	Dieldrin		.0074
6.5	Endrin		.0176
NL	Endrin Aldehyde		.0604
1.0	Endosulfan I		.0025
.7	Endosulfan II		.0077
3.0	Isodrin		.0025
35.9	Methoxyclor		.0750
2.2	Heptaclor		.0025
1.3	Heptachlor Epoxide		.0063
2.7	p,p-DDE		.0039
2.7	p,p-DDD		.0081
3.5	p,p-DDT		.0025
100	PCB-1016		.365
NL	PCB-1221		NL
NL	PCB-1232		NL
NL	PCB-1242		NL
NL	PCB-1248		NL
NL	PCB-1254		NL
47.9	PCB-1260		.176
226.0	Toxaphene		1.64

7.2.1 *Laboratory Certification*

The laboratory conducting the analysis of samples collected at JPG must use only methods that are approved and certified under the USATHAMA Quality Assurance Program (QAP) plan and must present evidence of current USATHAMA certification. Under this certification process, the laboratory's certified reporting limit is determined. Also determined is the range of concentrations for which the method is certified. Materials that exceed the range must be diluted.

7.2.2 *Sample Log-in and Inspection*

The subcontract laboratory's sample custodian will be responsible for the receipt and log-in of all samples from the field. The sample custodian will break the security seal on the cooler and check each shipment to verify that the sample security seals are in place and that the samples were received in good condition in the appropriate containers.

Samples will be logged in a bound-master sample-log notebook, and the condition of the samples will be recorded on the field chain-of-custody form. Immediately following physical log-in of the samples, the sample information will be entered into a database and a lot number will be assigned for each analysis.

The logged-in samples will be stored in a climate-controlled storage area (i.e., refrigerator/freezer specifically designed for sample storage and sample security locked room and/or locked refrigerator with limited access).

7.2.3 *Quality Control Samples*

Field QC Samples. Field QC samples to be collected and sent to the analytical laboratory include duplicates, VOC trip blanks, rinse blanks, and filtration blanks. Trip blanks will consist of organic-free water contained in amber glass VOC bottles shipped from the laboratory that will accompany each cooler containing samples for VOC analysis during shipment from the field to the laboratory (to determine if VOC contamination occurred during shipment). Rinse blanks will consist of water (from a USATHAMA-approved source) collected from sampling equipment following decontamination procedures to determine the effectiveness of cleaning. These samples will be analyzed for the same analytes as the samples collected for analysis at JPG. Filtration blanks will be collected for water samples requiring inorganic analysis. This will consist of a USATHAMA-approved water source being passed through the same filter system as the other samples.

Laboratory QC Samples. Spiked matrix samples are to be analyzed by the subcontract laboratory as required by the USATHAMA Quality Assurance Plan (QAP). These typically consist of four quality-control samples (one method blank, one low spike, and two high spikes) per sample lot. Sample lot sizes have been determined in existing certified methods. Efforts will be made by the subcontract laboratory to manage the sample flow in order to optimize lot size. Whenever possible, samples from the same installation will be analyzed within the same lot.

7.2.4 *Instrument Calibration*

Chemical calibrations of instruments will be performed for each target analyte using calibration standards prepared from standard analytical reference materials, interim reference materials, or off-the-shelf materials. These calibrations will be performed daily to ensure the instrument is functioning properly. Standard materials are obtained from USATHAMA, or the EPA, and/or are purchased from chemical suppliers. They are used as surrogate compounds, internal standards, and target-analytes standards during precertification, certification, chemical calibrations, and sample analysis (i.e., spiked samples). All standards will be kept in a locked storage area by the subcontract laboratory.

7.2.5 *Logs*

Documentation of all activities are to be kept in a bound laboratory notebook, on lab/field logs, and on QA/QC forms. Activities requiring logs will include, but not be limited to, sample log-in, chain-of-custody, instrument calibration, sample preparation, sample analysis spreadsheets, standard solution preparation, and corrective action (when required).

7.2.6 *Control Charts*

Under the USATHAMA laboratory certification program, the laboratory performing the sample analysis is required to produce control charts. These charts include Single Day XBAR and Range Control charts for high spikes, and Three-day Moving XBAR and Range Control charts for low spikes and gas chromotography/mass spectroscopy analyses. These control charts are reviewed for out-of-control situations and trends, which are remedied through a corrective action system. Typically, out-of-control samples will be reanalyzed unless holding times are exceeded.

7.2.7 *Audits, Surveillance, and Data Review*

A QA audit will be performed by the contractor and/or USATHAMA during the analytical phase of the RI at JPG utilizing the QA audit checklist presented in the USATHAMA QAP. Laboratory QA personnel will also be responsible for reviewing raw sample data and QC data prior to entry into the IRDMIS system. They will also be responsible for collecting and assembling a final data package for shipment to the contractor and USATHAMA.

8.0 REFERENCES

Ebasco Environmental, 1990a. Enhanced Preliminary Assessment Report: Jefferson Proving Ground, Madison, Indiana; prepared for U.S. Army Toxic and Hazardous Materials Agency, Aberdeen Proving Ground, Maryland, March 1990.

Ebasco Environmental, 1990b. Master Environmental Plan: Jefferson Proving Ground, Madison, Indiana; prepared for U.S. Army Toxic and Hazardous Materials Agency, Aberdeen Proving Ground, Maryland, November 1990

Environmental Science and Engineering, Inc., 1989. Remedial Investigation at Jefferson Proving Ground, Draft Technical Report A011; prepared for U.S. Army Toxic and Hazardous Materials Agency, Aberdeen Proving Ground, Md., January 1989.

Hartke, E. J., 1989. Geology of Jefferson Proving Ground; Indiana Department of Natural Resources.

U.S. Army Corps of Engineers, 1988. RCRA Part B Permit Application for Open Burning/Open Detonation; Nashville, Tennessee.

______, 1991. Closure of Jefferson Proving Ground, Indiana and Realignment to Yuma Proving Ground, Arizona: Environmental Impact Statement (Vol. 1 & 2); prepared by the Louisville District.

USAEHA, 1988. Interim Final Report, Ground Water Contamination Survey No. 38-26-0306-89, Evaluation of Solid Waste Management Units, Jefferson Proving Ground, Madison, Indiana.

U.S. Department of Agriculture and Soil Conservation Service, 1985a. Soil Survey of Jennings County, Indiana.

______, 1985b. Soil Survey of Ripley County and Part of Jennings County, Indiana.

______, 1985c. Soil Survey of Jefferson County, Indiana.

U.S. Department of Interior, 1985. An Archeological Overview and Management Plan for Jefferson Proving Ground, Jefferson, Jennings, and Ripley Counties, Indiana; National Park Service, Contract No. CX-5000-3-0771.

U.S. Environmental Photographic Interpretation Center (EPIC), 1986. Installation Assessment Relook Program Working Document, Jefferson Proving Ground, Madison, Indiana; Warrenton, Virginia, TS-PIC-85X.

U.S. Environmental Protection Agency (EPA), 1986. Test Methods for Evaluating Solid Waste, SW-846, Third Edition, November 1986.

______, 1988. Draft Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA; OSWER Directive 9335.3-01.

______, 1989a. Risk Assessment Guidance for Superfund, Vol. I: Human Health Evaluation Manual (Part A); EPA 540/1-89/001.

______, 1989b. Risk Assessment Guidance for Superfund, Vol. II: Environmental Evaluation Manual; EPA 540/1-89/002.

______, 1990. Environmental Audit: Jefferson Proving Ground, Madison, Indiana; prepared by the National Enforcement Investigations Center, Denver, Colorado, April 1990.

APPENDIX A

APPENDIX A

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SURFACE SOIL SAMPLING

INTRODUCTION

For samples to be collected from a depth of 0-6 inches, a stainless steel scoop or trowel will be used for sample collection. For samples over 6 inches in depth, a hand-operated stainless steel barrel auger will be used. The barrel auger maintains a consistent sample volume and allows better depth control. Sediment sampling at JPG will also employ this procedure since the stream drainages at JPG are shallow and often dry.

SIGNIFICANCE AND USE

Samples will be obtained for the determination of the presence or absence of chemical contamination in the near-surface soil environment. The sampling equipment used and the procedures are designed to minimize the potential for cross-contamination between samples and to obtain samples of a relatively uniform depth and volume.

APPARATUS

Surface soil sampling will utilize a stainless steel spoon, scoop, or trowel to excavate a hole over a small area (< 1 foot) to a depth of 6 inches. The barrel auger consists of a stainless steel, 3-inch-diameter auger tube with cutting tips hardened and sharpened to penetrate the soil. Attached to the upper end of the auger barrel is a threaded stainless steel extension rod to which a T-handle is attached. The auger assembly is rotated by hand in a clockwise direction.

PROCEDURE

1. Clear immediate sampling area of debris or litter.

2. For the spoon or scoop method, first collect samples for VOC analysis by placing the sample material directly into the sample container with minimal head space to minimize VOC loss. Place remaining material in a precleaned stainless steel pan and thoroughly mix the material with a stainless steel spoon. Place the mixed sample into the appropriate sample containers.

3. For the barrel auger sampling method, auger to the desired sampling depth. When the desired depth is reached, remove the auger. If a sample for VOC analysis is required, remove the material immediately using a stainless steel spoon and place in the appropriate container with no headspace to prevent volatile loss. Place the remainder of the sample material in a precleaned stainless steel pan and mix thoroughly with the spoon. Transfer the sample material from the pan to the appropriate containers with the spoon.

4. With a clean paper towel, clean the outside threads of the bottle prior to placing the lid on the bottle, since dirty threads often result in a poor seal. A tight seal is essential to prevent escape of the sample or specific chemical contaminants within the sample.

5. Wrap a seal of parafilm tape around the bottle and lid to secure the lid.

6. Measure the actual sampling depth using a steel measuring tape and record on the soil sample log sheet.

7. Note any unusual characteristics observed such as color, texture, or odor on the log sheet.

8. Record the sampling time, date, sampler's name, sample ID number, and requested analytical parameters on the sample bottles and sample log sheet. Once the sample tag is completed for each container, cover the tag with clear tape to protect it from moisture.

9. Prepare and store the samples as specified in Section 5.4.3 of the Sampling Design Plan.

10. Decontaminate all sampling equipment that came into contact with potentially contaminated materials as specified in the decontamination procedures described in Section 5.7 of the Sampling Design Plan.

SUBSURFACE SOIL SAMPLING

INTRODUCTION

This method describes the procedures that will be used to obtain representative subsurface soils samples which are to be analyzed for specific chemical analyses. The method to be used for subsurface soil sampling at JPG is split-barrel soil sampling using hollow-stem augers and a stainless steel split-barrel sampler.

SIGNIFICANCE AND USE

The primary focus of the field investigation when utilizing this method will be to obtain discrete soil samples for analytical determination of in-situ chemical contamination and to ensure that the samples are free from cross contamination. The samples will be obtained in a manner consistent with the Sampling Design Plan (Volume II) and the Health and Safety Plan (Volume IV). the sampling procedure will provide the proper level of data as outlined in the Data Quality Objectives defined in the Technical Plan (Volume I).

The second focus of the subsurface soils investigation using the split-barrel method is to provide subsurface lithologic information to supplement previous investigation information on subsurface lithology of JPG.

APPARATUS

The split-barrel sampler will have a 3-inch O.D., 2.5-inch I.D., and 24-inch length. The barrel will be constructed of stainless steel. Since the standard size used for the ASTM D1586-84 method of penetration testing is 2-inch O.D., the blow count data will be recorded but calculations will not be made. The larger split-barrel sampler will be used to ensure sufficient sample material is available for the various chemical analyses required.

A truck-mounted, hollow-stem auger rig will be employed to complete the subsurface soil sampling at JPG. The auger rig will be equipped with a 140-pound drop hammer having a 30-inch drop or an equivalent hydraulic driver.

DRILLING PROCEDURE

1. All equipment will be decontaminated according to the procedures specified in Section 5.7 of the Sampling Design Plan prior to commencing work.

2. If required, conduct a surface sweep and location survey with a magnetometer for UXO and utilities prior to the start of drilling/sampling.

3. Spread a minimum 6-mil plastic sheet over the borehole location of sufficient size to contain the anticipated volume of drill cuttings.

4. With the truck-mounted auger rig centered over the pre-determined boring location, place the split-barrel sampler on the ground surface and allow the drop hammer to drive the sampler the full length of the barrel or to the desired depth if less than 2 feet. If samples are to be collected only at discrete intervals, the hollow-stem auger will be used to auger to the top of the interval to be sampled. The sampler will be lowered to the top of the interval to be sampled and the sampler will then be driven for the full length of the sampler or until no further penetration is achieved after 50 blows for each 6 inches of penetration.

5. Once the sampler is filled, carefully remove the sampler from the borehole and separate from the drive-rod assembly. Using a clean plastic sheet laid on a flat surface, remove the drive head and shoe. This will allow one-half of the split-barrel to be removed, exposing the sample.

6. If the material in the sampler is to be collected for volatile organic analysis, immediately scan the material with a photoionization detector. Upon selection of the zone to be sampled, fill the appropriate container as soon as possible to avoid loss of volatiles with a stainless steel spoon and transfer directly "as-is" to the sample container. With minimal headspace and with the bottle thread wiped clean, tighten the lid and prepare and store the sample as specified in Section 5.4.3 of the Sampling Design Plan.

7. Visually scan the material in the sampler and note on the lithologic log a description of the material including color, odor, texture, particle sizes, moisture condition, and if present, visual evidence of contamination. Classify according to the Unified Soil Classification System.

8. Discard the top "slough" portion of the sample in an appropriate container. Transfer the remaining core (following removal of material for VOC analysis) to a pre-cleaned stainless steel mixing pan using a stainless steel spoon or spatula. Thoroughly mix the sample material and place into the appropriate containers. If a discrete section of the sample shows evidence of significant contamination, this section will be sampled without mixing the entire sample.

9. Record the depth, time collected, date collected, sampler's name, sample ID number, boring or well ID, and required analyses on the sample labels and soil sample log sheet. Once information is recorded on the sample label, cover the label with clear tape to protect the label from moisture.

10. Barrel remaining drill cuttings and label the barrel with the boring ID number, range of depths of the cuttings within the barrel, and the date barreled.

11. Decontaminate all drilling and sampling equipment according to the procedures outlined in Section 5.7 of the Sampling Design Plan.

MEASUREMENT OF WATER LEVELS IN GROUNDWATER MONITORING WELLS

INTRODUCTION

Water-level measurements will be taken prior to any sampling or well purging. These measurements are needed to determine the casing volume of water in the well; the data is used when interpreting the monitoring results. High water levels could indicate recent recharge to the system, resulting in dilution of the sample. Low water levels may reflect the influence of nearby production wells. Documentation of the non-pumping water levels will also provide historical information on the hydraulic conditions at the site.

SCOPE

The water-level measurements will be made from the top of the well casing and, for consistency, will always be made from the same spot on the well casing (typically on the north side of the casing).

Two methods are provided for water-level measurements. The first utilizes an electric sounder with a conductivity cell. When the cell contacts water, it completes an electrical circuit and sounds a buzzer or lights a lamp. The second method uses an interface probe. This instrument has an optical liquid sensor and a conductivity cell and can distinguish between the presence of a non-conductive layer (i.e., oils and fuels) and a conductive layer. With this instrument, the sampler can measure the thickness of a light-phase immiscible (floater) or dense-phase immiscible (sinker) layer.

SIGNIFICANCE AND USE

Accurate measurements of water depth are necessary to calculate well-bore volumes; measurements are typically made to the nearest 0.01 foot.

APPARATUS

Electric Sounder or Interface Probe (many commercial brands are available)

PROCEDURE

1. Ensure that the sounder or interface probe is clean by rinsing with distilled water and wiping clean with a lint-free disposable tissue.

2. Perform a battery check.

3. Slowly lower the probe into the well until the indicator sounds or lights. In the case of the interface probe, a continuous audible alarm indicates an immiscible non-conductive liquid and an oscillating alarm indicates water.

4. Raise the probe slightly until the indicator stops sounding or the light goes off. Lower the probe again until the indicator sounds and read the depth to the nearest 0.01 foot. Repeat this step until a repeatable measurement is achieved (to the nearest 0.01 foot).

5. If a dense-phase immiscible layer is suspected, it can be measured by slowly lowering the interface probe to the bottom of the well. If the layer is present, it can be measured by recording the point at which the continuous alarm begins and the point that the probe reaches the bottom of the well.

6. Slowly withdraw the probe from the well while wiping the tape with a clean lint-free tissue moistened with distilled water.

7. Clean the probe by rinsing with distilled water and wiping dry with a lint-free tissue.

PURGING OF MONITORING WELLS

INTRODUCTION

To obtain a representative groundwater sample, the stagnant water in the well casing must be removed. The recommended amount of purging depends on many factors such as the hydrogeological nature of the aquifer, the characteristics of the well, the type of sampling equipment to be used, and the parameter to be sampled. USATHAMA requirements call for the purging of five bore-volumes. In addition to the established number of bore volumes, water quality parameters of pH, conductivity, and temperature will be measured to indicate when the stagnant water has been sufficiently removed (the measurements stabilize).

SCOPE

The four methods described here are representative of those generally used to purge monitoring wells. Each method has advantages and disadvantages that must be considered. Proper selection will be based on such variables as the total volume of material to be removed, depth of water to be removed, and chemical contaminants present.

SIGNIFICANCE AND USE

Water may become stagnant in a well and will not reflect the local resident water's chemical and physical properties. The purging of a well can reduce this bias. Care shall be taken to allow screened intervals to come to equilibrium before sampling is performed.

CALCULATION OF VOLUME OF STANDING WATER IN THE WELL

Calculations are performed for the amount of water in the well with the following formula:

$r^2 \times \pi \times (h1 - h2) \times 7.48 =$ gallons per casing volume

where

r = radius of well casing (feet)
h1 = depth of well (feet) from the top of the well casing
h2 = depth to water (feet) measured from the top of the well casing

WELL PURGING PROCEDURES

Peristaltic Pump

Apparatus:

Peristaltic-type pump
Silicone or neoprene tubing for pump head
Silicone, Teflon, polyethylene, or vinyl tubing for placing in the well
Generator or other source of electricity

Procedure:

1. Place the suction line in the well so it is just below the liquid surface.

2. Connect the suction line to the pump.

3. Connect the pump outlet to the in-line flow cell or place the pump outlet hose into an open container to be used to make the field measurements of pH, conductivity, and temperature.

4. Place calibrated pH, conductivity, and temperature electrodes into the in-line flow cell or the open container.

5. Initiate pumping and follow the water level down the well bore if the recovery rate of the well is below the pumping rate. Discharge hose should be placed in the tank or barrel for containment.

6. Routinely monitor and record the volumes purged and the readings for the pH, conductivity, and temperature.

7. When the calculated volume of water in five bore-volumes has been purged from the well, discontinue pumping. Sampling can now begin.

8. Remove the suction line from the well if sampling is not to be accomplished with the pump (i.e., sampling with a bailer).

9. Decontaminate the equipment according to the procedure described in Section 5.7 of the Sampling Design Plan.

NOTE: Purging with a peristaltic pump is normally limited to situations where the water levels are less than about 25 feet. Also degassing occurs using this method when there is a head difference between the pump and the water level.

Bladder-type Pump

Apparatus:

Bladder-type pump
Air compressor
Teflon, polyethylene, or vinyl tubing for the air and sample line

Procedure:

1. Lower the pump gently to a position just above the screened interval.

2. Connect the air line to the pump controller.

3. Connect the pump outlet to an in-line flow cell or place the pump outlet hose in an open container used to make field measurements.

4. Place calibrated pH, conductivity, and temperature electrodes in the flow cell or the open container.

5. Initiate pumping and routinely monitor and record the volume purged and the pH, conductivity, and temperature measurements.

6. During pumping, discharge the water to a containment tank or 55-gallon barrels.

7. When five bore-volumes have been purged from the well, discontinue pumping.

8. Remove the pump from the well and decontaminate all purging equipment according to decontamination procedures described in Section 5.7 of the Sampling Design Plan.

NOTE: Pumping rates for this type of pump are typically slow, there is a high rate of air consumption, and decontamination of the equipment is more difficult than with other methods.

Bailer

Apparatus:

Teflon or Stainless Steel Bailer
Teflon or Stainless Steel Cable or Line
Bailer Reel

Procedure:

1. Attach the bailer to the cable or line which is contained on a handled reel.

2. Lower the bailer until it contacts the liquid.

3. Allow the bailer to sink until it is totally submerged.

4. Slowly raise the bailer to the surface.

5. Tip the bailer or use a bottom-emptying device and fill a container in which calibrated pH, conductivity, and temperature probes have been placed.

6. Continue bailing and emptying until five bore volumes have been bailed. As the container is filled, the purge water will be transferred to a larger container (i.e., tank or 55-gallon drum) for containment and storage. Measurements of pH, conductivity, and temperature will be made periodically in the smaller container (typically a 5-gallon bucket).

7. Clean and decontaminate the bailer as required. If the well has a dedicated bailer, the bailer will not have to be decontaminated.

NOTE: Use of a bailer for deep or large diameter wells is labor intensive and time consuming. Degassing, aeration, and turbulance will occur with this method. Also, it is difficult to determine the depth to which the bailer has been submerged.

Submersible Pump

Apparatus:

Submersible-type Pump
Discharge tubing of vinyl, polyethylene, polyvinyl chloride, or Teflon
Power source of generator or batteries

Procedure:

1. Set up the pump according to the manufacturer's operating manual.

2. Gently lower the pump down the well so that the pump head is submerged sufficiently and will not run dry.

3. Connect the pump outlet to an in-line flow cell or place the pump outlet in an open container used for field measurements.

4. Place calibrated pH, conductivity, and temperature electrodes in the flow cell or the open container.

5. Initiate pumping and continue pumping until five bore volumes have been purged. Discharge will be placed in tanks or 55-gallon drums for containment and storage. During pumping, continue to monitor pH, conductivity, and temperature.

6. Remove the pump from the well and decontaminate the equipment according to decontamination procedures described in Section 5.7 of the Sampling Design Plan.

NOTE: The high pumping rate and the mechanical action of this type of pump causes turbulence, aeration, and degassing of the water. Also these pumps are easily damaged by dry pumping. The equipment may be difficult to clean and decontaminate.

DOCUMENTATION REQUIREMENTS

The following information must be recorded prior to or during the purging of a well:

- Depth to water
- Depth of well
- Well diameter or radius
- Calculated water volume
- Type of equipment used to evacuate the well
- Date
- Well ID
- Name of person(s) performing the purging
- Total volume purged
- pH, conductivity, and temperature measurements and time or volume when taken

FIELD MEASUREMENT OF pH

INTRODUCTION

An accurate pH measurement is critical for the prediction and interpretation of the reactions and migration of dissolved species. This procedure provides a useful pH measurement under most field conditions.

SCOPE

This method contains the procedures for the measurement of pH in an aqueous solution. The pH is determined using a glass hydrogen-ion electrode compared against a reference electrode of known potential by means of a pH meter.

SIGNIFICANCE AND USE

The pH of a solution is defined as the negative logarithm to the base 10 of the hydrogen-ion activity in moles per liter: $pH = -\log[H^+]$. Because pH is exponentially related to concentration, great care shall be taken in making the measurement.

Natural waters usually have pH values in the range of 4 to 9. The primary control over pH in natural waters is the carbonate system, including gaseous and dissolved carbon dioxide, bicarbonate, and carbonate ions.

Temperature, atmospheric contamination, and ionic strength are factors that affect pH measurements. The pH measurement is relatively free from interference from color, turbidity, colloidal matter, oxidants, or reductants.

APPARATUS

pH Meter - Numerous pH meters are available; the meter used should have a temperature compensating device, a slope adjustment, and be capable of reading pH to +/- 0.1 units
Flow Cell - for continuous flow measurements
Standard pH buffer solutions - 4, 7, 9 or 10
Combination pH electrode
Temperature-measuring device - capable of reading temperatures to +/- 0.1°C
Distilled water in a squeeze wash bottle
Lint-free tissue
Disposable beakers, test tubes, or centrifuge tubes

CALIBRATION

In each case, samplers will follow the manufacturer's instructions for the pH meter and electrode used. Electrodes shall be kept wet when not in use. Recommended solutions for storage are the pH 4.00 or pH 7.00 buffer.

Before use, remove electrode from the storage solution, rinse with distilled water, and blot dry with a lint-free tissue.

Adjust buffer solution and electrode to +/- 10°C of the sample temperature. This can be done by storing the buffer solutions and electrode in an ice chest or by letting sample water run over the buffer bottles and electrode until the temperatures have equilibrated.

Place the electrode in the pH 7.00 buffer, adjust the temperature compensation control to the temperature of the buffer, and adjust the calibration control to read the pH of the buffer. The pH of the buffer is equal to 7.00 only at 25°C; therefore, it is necessary to use the temperature-correction curve supplied by the manufacturer of the buffer.

Remove the electrode from the 7.00 buffer, rinse with distilled water, and blot dry. Place the electrode in either the pH 4.00 or the pH 10.00 buffer, bracketing the expected pH of the sample. Allow the reading to stabilize before making adjustments. Adjust the slope control to read the correct pH, again consulting the temperature-correction curve supplied by the manufacturer.

Rinse electrode with distilled water and blot dry. Recheck the value of the pH 7.00 buffer. The value must be within +/- 0.02 pH of the correct value. If not, repeat the calibration.

MEASUREMENT PROCEDURE

1. Consult the instrument-specific operating manual for equipment setup and operational checks. Perform any pre-measurement checks and calibrations according to manufacturer's operating procedures.

2. Rinse the calibrated electrode with distilled water, blot dry, and immerse the electrode in the solution to be measured.

3. Use of a flow cell is recommended for making pH measurements; this reduces the interferences due to atmospheric contamination. If possible, in-situ measurements are best.

4. Allow the measurement to stabilize and record the reading.

5. Remove the electrode from the solution, rinse with distilled water, blot dry, and store in pH 4.00 or pH 7.00 buffer solution.

DOCUMENTATION

- Log the time of the last two-buffer calibration. This calibration should be performed a minimum of once each hour.
- Record the buffer temperature at time of calibration.
- Record sample temperature at time of measurement
- Measurement type (in-situ, open container, air-exclusion container)
- Source and expiration date of buffers used
- Instrument manufacturer and model number
- Name of person performing the measurement, date, and time

MEASUREMENT OF SPECIFIC CONDUCTANCE

INTRODUCTION

Specific conductance is a widely used indicator of water quality. It measures the ability of water to carry an electrical current under specific conditions. This ability depends on the presence of ions, their total concentration mobility, and temperature. Specific conductance is a simple indicator of change within a system and is used as an aid in evaluating whether a sample is representative of the water in the system.

SCOPE

This procedure describes the field measurement of the specific conductance of an aqueous sample. The specific conductance is measured using a conductance meter and a platinum or stainless steel electrode.

SIGNIFICANCE AND USE

The specific conductance or conductivity of a sample is defined as the conductance of the sample between opposite sides of a cube, 1 centimeter (cm) in each direction. Because it is impractical to build electrodes with these characteristics, electrodes are manufactured in various forms. A cell constant is determined by measuring a solution of known conductivity. Solutions of known conductivity are purchased or can be made from reagent-grade KCL. Samplers will consult operating instructions for the specific instrument used for the determination of the cell constant. This conductivity is expressed in micromhos per centimeter (μmhos/cm).

INTERFERENCES

Temperature, ionic strength, and the determination of the cell constant are features that affect the measurement of conductivity.

The conductivity of a solution increases with temperature at approximately 2 percent per degree C. Significant errors can result from inaccurate temperature measurements. If the conductivity meter does not have automatic temperature correction, the sampler can use the following formula to correct the conductivity reading for temperature.

$$K = \frac{EM}{1 + 0.0191(t-25)}$$

where

K = corrected conductivity in μmhos/cm,
EM = measured conductivity in μmhos/cm, and
t = temperature in °C

The conductivity of a solution is a function of the concentration and charge of the ions in solution and of the rate the ions move under the influence of an electrical potential. As the ionic strength increases, the rate the individual ions move decreases. Conductivity varies linearly with ionic strength for values below 1,000 μmhos/cm. As conductivity increases above 5,000 μmhos/cm, the line curves significantly; beyond 50,000 μmhos/cm, the conductivity is an unsatisfactory index of ionic concentration.

The cell constant will be checked and verified on a regular basis. A significant change in the cell constant indicates that the electrode needs cleaning or changing. Consult the instrument operating manual for procedures to check the cell constant.

APPARATUS

- Specific conductance meter - capable of measuring conductivity in the range of 0 to 100,000 μmhos/cm and temperatures in the range of -5°C to 50°C
- Conductivity check solutions (0.001N, 0.01N, and 0.1N KCL)
- Distilled or deionized water in a squeeze bottle
- Disposable beakers, test tubes, or centrifuge tubes
- Lint-free tissue

PROCEDURE

1. Rinse the conductivity cell and temperature probe with several volumes of sample water.

2. Immerse the probe and cell in the sample.

3. Allow the readings to stabilize and record the temperature and conductivity readings on the field log form.

4. Remove the probes from the solution, rinse with distilled water, blot dry, and store according to the manufacturer's procedures.

DOCUMENTATION

- Record the source and expiration date of standards used
- List instrument manufacturer and model number
- Record date and time of calibration check
- Record temperature and conductivity of standards used to check calibration
- Record sample temperature and conductivity readings
- List the name of the person performing the measurement(s)

FIELD MEASUREMENT OF TEMPERATURE

INTRODUCTION

Temperature readings are important for numerous applications. They are used in the measurement of Eh, pH, conductivity, and dissolved oxygen; and in saturation and stability studies. It is important to know the temperature of surface waters and groundwaters for the accurate geochemical evaluation of equilibrium thermodynamics. Temperature readings of +/- 1°C are necessary for the above applications.

SCOPE

This procedure gives general guidance and recommendations that will be considered when taking a temperature measurement. There are numerous instruments on the market that can provide adequate temperature measurements. Each instrument operating manual should be consulted for detailed procedures.

SIGNIFICANCE AND USE

Temperature is a basic physical property that is measured by the response of matter to heat. There are many devices that, once calibrated, are acceptable for taking temperature measurements. These devices include liquid in glass (mercury in glass), thermocouples, bimetallic, and electrical-resistance thermometers. At a minimum, the device should measure temperature to +/- 0.1°C readability.

APPARATUS

- Temperature measuring device
- Distilled or deionized water in a squeeze wash bottle
- Lint-free tissue

PROCEDURE

1. The temperature measuring device should be calibrated according to the instrument operating manual supplied by the manufacturer of the device.

2. Rinse the thermometer with distilled or deionized water and blot dry.

3. Immerse the thermometer in the sample.

4. Allow the reading to stabilize and record the temperature.

DOCUMENTATION

- Record the manufacturer and model of the instrument used.
- Record the temperature measurement of the sample.
- List the name of the person performing the measurement, time, and date.

STANDARD PRACTICE FOR THE SAMPLING OF LIQUIDS

INTRODUCTION

The type of sampling equipment used for sampling liquids at JPG will depend on the sample to be collected, which analytes the sample is being collected for, and the site-specific requirements such as depth to water, depth of well, etc. Because each sampling situation is unique, the equipment used and its application may have to be modified to ensure that a representative sample is collected and it physical and chemical integrity is maintained.

SCOPE

The procedures listed here are used to collect liquid samples. There are several methods that can be used to collect liquid samples. Some sampling situations use a combination of these methods. For example, a peristaltic pump could be used to collect the inorganic samples and a bailer used to collect the organic samples. The methods likely to used at JPG are:

- Sampling with a Peristaltic Pump
- Sampling with a Bladder Pump
- Sampling with a Bailer
- Sampling with a Submersible Pump
- Sampling by Container Immersion

SIGNIFICANCE AND USE

The usefulness and limitations for each of the first four sampling methods are described as follows:

Peristaltic Pump:

Advantage	Disadvantage
Flow rates are easily adjustable. Device has no contact with the sample. Device can be used in wells of any diameter. High flow rates are obtainable for well purging. Only the tubing requires cleaning (peristaltic pumps only).	Use is limited to situations where the liquid level is less than 25 feet below the surface. Drop in pressure of suction-lift mechanisms causes degasing of the sample and loss of volatiles. Choice of construction material is limited. Centrifugal pumps need to be primed, resulting in possible sample contamination. Severe aeration and turbulence occur with centrifugal pump.

Bladder Pump:

Advantage	Disadvantage
Pump is constructed of inert materials; most pumps are designed specifically to sample for low levels of contaminants.	Deep sampling requires large volumes of gas and longer cycles, thus increasing operating time and expense and reducing portability.
Driving gas does not contact the sample, thus minimizing sample aeration and gas stripping.	Check valves in some models are subject to failure in water with high solids content.
Pump is portable, though accessory equipment may be cumbersome.	Most available models are expensive.
Relatively high pumping rate allows well evacuation and collection of large sample volumes.	Minimum rate of sample discharge of some models may be higher than ideal for sampling of volatile compounds.
Sample delivery rate can be controlled easily on some models.	
Most models are capable of pumping lifts in excess of 200 feet.	
Pump diameters are variable, depending on the application.	
Pump is easily disassembled for cleaning.	

Bailer:

Advantage	Disadvantage
Virtually any material can be used for construction.	Sampling is labor-intensive and time-consuming.
Device is inexpensive.	Aeration, degasing, and turbulence occur during sampling.
No external power source is required.	Sampler is susceptible to exposure to any contaminants in the sample.
Mechanism can be constructed in any size and shape.	Device does not provide a continuous supply of sample.
Device is easy to use and easily cleaned; requires little training for operation and little maintenance.	

Submersible Pump:

Advantage	Disadvantage
High pumping rates are possible for well purging.	Sampler has little control of flow rates; not possible to adjust from a high rate for purging to a low rate for sampling.
Pump can be used at depths of more than 200 feet.	Severe aeration and degasing of sample occurs, thus volatilizing organics and other sensitive compounds.
	Pump has limited portability and requires a power source for operation.
	Pump is not easily disassembled for cleaning.

METHOD 1 - SAMPLING WITH PERISTALTIC PUMP

Apparatus

- Peristaltic-type pump
- Silicone, C-Flex, or Norprene tubing for the pump head
- Silicone, Teflon, polyethylene, or vinyl tubing for the suction line (placed in sample liquid)
- Generator or other source of electricity

Procedure

1. Place the suction line in the liquid to be sampled. If sampling a monitoring well, place the tubing just above the screened interval.

2. Connect the suction line to the pump.

3. Turn on the pump and adjust the flow rate so sample turbulence is at a minimum. Allow several liters to flow and recheck stability parameters (i.e., pH, conductivity, temperature).

4. Fill the necessary sample bottles by allowing the pump discharge to flow gently down the side of the bottle with minimal turbulence.

5. Label, preserve, and document the sample as required.

6. Remove the tubing from the liquid and clean and decontaminate equipment as required.

NOTE: Sampling organics using a peristaltic pump is not recommended. The suction lift action will strip volatiles and degas the sample. Also the tubing tends to absorb some organics and slowly releases them, contaminating subsequent samples.

METHOD 2 - BLADDER PUMP

Apparatus

- Bladder-type pump
- Air compressor
- Teflon, polyethylene, or vinyl tubing for the air and sample line

Procedure

1. Lower the pump gently to a position just above the screened interval.

2. Connect the air line to the pump controller.

3. Initiate pumping and allow several liters of water to be pumped prior to sample collection (recheck stability parameters of pH, conductivity, and temperature).

4. Fill the necessary sample bottles by allowing the pump discharge to flow gently down the side of the bottle with minimal disturbance.

5. Label, preserve, and document the sample as required.

6. Remove the pump from the well and clean and decontaminate as required.

METHOD 3 - SAMPLING WITH A BAILER

Apparatus

- Teflon or stainless steel bailer
- Teflon or stainless steel cable or line
- Bailer reel and tripod

Procedure

1. Attach a properly pre-cleaned bailer to the cable or line.

2. Lower the bailer slowly until it contacts the liquid.

3. Allow the bailer to sink until it reaches the screened interval of the well or the desired sampling depth.

4. Slowly raise the bailer to the surface.

5. Tip the bailer or use a bottom-emptying device and fill a container to recheck the stability parameters (pH, conductivity, and temperature).

6. Repeat the bailing procedure as many times as necessary to fill the required sample bottles.

7. Clean and decontaminate the bailer as required.

NOTE: A bottom-emptying device is recommended for the collection of volatile organic compounds using a bailer.

METHOD 4 - SAMPLING WITH A SUBMERSIBLE PUMP

Apparatus

- Submersible-type pump
- Discharge tubing of vinyl, polyethylene, or Teflon
- Power source of generator or batteries

Procedure

1. Set up the pump according to the operating manual.

2. Gently lower the pump to a position just above the screened interval.

3. Initiate pumping and allow several tubing volumes of liquid to be pumped prior to sample collection. Recheck stability parameters (pH, conductivity, and temperature).

4. Fill the necessary sample bottles by allowing the pump discharge to flow gently down the side of the bottle with minimal turbulence.

5. Label, preserve, and document the samples as required.

6. Remove the pump, clean and decontaminate as required.

NOTE: Considerable agitation results when using a submersible pump. Submersible pumps are not recommended for the collection of dissolved gases, organics, or oxidation/reduction sensitive samples. They also have a higher potential of sample contamination because of the construction material.

METHOD 5 - SAMPLING BY CONTAINER IMMERSION

Apparatus

- Sample Containers
- Disposable gloves (type(s) as specified in the Health and Safety Plan)
- Distilled water in a squeeze bottle
- Lint-free tissues

Procedure

1. After putting on the appropriate gloves, rinse the sample container three times with the liquid to be sampled.

2. Submerge the sample bottle below the liquid surface. If the liquid is flowing, point the bottle upstream.

3. Allow the container to fill to the desired volume.

4. Remove the container, cap, and rinse the container's outside surface with distilled water and dry with a clean tissue.

5. Label and preserve the sample as required.

NOTE: For samples collected for VOC analysis, fill the bottle with zero air space. After capping, turn the bottle over and check for bubbles. If present, the procedure must be repeated.

COLLECTION, FILTRATION AND PRESERVATION OF LIQUID SAMPLES

INTRODUCTION

Many factors should be considered during the sample-collection phase. These factors include bottle type, bottle size, preservative, whether the sample should be filtered, in what order the samples should be collected, etc. The procedures listed here are presented to cover the sampling requirements anticipated for JPG.

SCOPE

This procedure covers the collection, filtration, and preservation of liquid samples. Provided are general collection procedures, specific collection procedures for the collection of organics, procedures for sample filtration, and procedures for sample preservation.

SIGNIFICANCE AND USE

Table 1 (from Table H-1 of the USATHAMA QAP) lists many of the standard methods for sample preservation and bottles that may be required for sample collection. Improper bottling, filtration, or preservation may compromise the integrity of the sample.

APPARATUS

- Sample bottles
- Sample labels
- Preservative solutions (see Table 1)
- Dispensers for preservative solutions
- Coolers and ice for storing collected samples at 4°C
- In-line filter holders and filters of 0.45 micrometer pore size

GENERAL SAMPLE COLLECTION PROCEDURES

1. All samples will be collected as close to the source as possible.

2. Choose the appropriate bottles for the analytes needed (Table 1). Visually inspect the bottle for cleanliness, breaks, or missing parts prior to sampling.

3. Label the bottles as required under the Sampling Design Plan.

4. Collect the samples by allowing the liquid to flow gently down the side of the bottle with minimal turbulence. Unfiltered samples will be collected prior to filtered samples.

5. Unfiltered samples should be collected in the following order:

   - Volatile organics and total organic halides
   - Dissolved gases and total organic carbon
   - Large-volume samples for organic compounds
   - Sensitive inorganics (i.e., NO_2-, NH_4+, Fe(II))
   - Total metals

6. Filtered samples should be collected in the following order:

   - Alkalinity
   - Sensitive inorganics
   - Trace metals
   - Major cation/anions

7. Add preservatives as required.

8. Cap the bottle securely. Rinse the outside surface with distilled water and wipe dry with a clean lint-free tissue.

9. Store as required. Most samples require storage at 4°C immediately after collection. A cooler with ice will be used for field storage and transport.

Sampling Non-Volatile Organics

1. Samples for non-volatile organics are collected directly into the sampler container. The container will be cleaned to EPA standards or purchased from a supplier that has them pre-cleaned to EPA standards (i.e., I-CHEM). Do not filter samples for organics.

2. Choose the appropriate bottle for the analyte(s) requested.

3. Label the bottle as required by the Sampling Design Plan.

4. Add preservative to the bottle, if required.

5. Slowly fill the bottle by allowing the liquid to flow gently down the side of the bottle with minimal turbulence.

6. Cap the bottle securely.

7. Store as required at 4°C.

Sampling for Volatile Organics

1. When sampling for volatile organics, special care will be taken during collection of the sample to reduce the possibility of significant loss of volatile constituents. Volatile organics should be the first samples collected. They are collected in a 40-milliliter (mL) vial that has a Teflon-lined, silicone-septum lid.

2. Properly label the bottle.

3. Slowly fill the bottle to overflowing.

4. Hold the container level and place the septum Teflon-side down on the convex water meniscus and seal with the screw cap.

5. Test the seal by inverting the vial and lightly tapping. There are to be no bubbles entrapped in the sample. If bubbles are present, uncap the container, add additional sample, and reseal as stated above.

SAMPLE FILTRATION PROCEDURE

Samples requiring filtration will be collected after unfiltered samples. To maintain closed-system conditions, an in-line membrane filter is connected directly to the pump outlet. This allows the sample to be filtered prior to atmospheric contact, which could alter the sample. A filter pore size of 0.45 μm is used for sample filtration.

1. Connect the in-line filter directly to the pump outlet.

2. Start the pump and discard the first 100 mL of sample. This flushes the filter of any excess distilled water used for prior cleaning of the filter assembly.

3. Place the sample bottles directly under the filter outlet and fill to the desired volume.

4. Preserve the sample as required.

5. Stop the pump, disconnect and disassemble the filter.

6. Discard the used filter and clean all surfaces of the filter holder with distilled water and wipe dry with a clean lint-free tissue.

7. Place a new filter in the holder and reassemble.

SAMPLE PRESERVATION PROCEDURE

Samples are preserved by a variety of means to stabilize specific parameter so that the samples can be shipped to a laboratory for analysis. Preservatives are designed to retard

biological effects, retard hydrolysis, reduce sorption effects, and reduce volatility of constituents. Preservation methods are generally limited to pH control, chemical addition, refrigeration, and protection from light. The following guidelines will be considered during sample preservation.

Preservation of samples requires the use of a variety of strong acids and bases. Care should be taken in their storage and use. Review of the MSDS sheet should be made before use and the appropriate eye and skin protection should be in place prior to use (i.e., goggles and gloves).

1. Preserve sample as soon after collection as possible.

2. For acidified samples, check the pH of the sample prior to capping. If needed, add more acid until the proper pH is attained (i.e., < 2).

3. Samples requiring cooling should be placed in an ice chest with wet ice immediately after collection.

4. Record any preservatives used on the sample label and the resulting pH, if applicable.

Table 1 Containers, Preservation, Storage, and Holding Times[a]

Parameter	Container[b] Water	Soil	Preservative[c,d] Water	Soil	Maximum Holding Time for all Matrices[e]
INORGANIC TESTS					
Acidity	P	G	Cool, $4^{o}C$	Cool, $4^{o}C$	14 days
Alkalinity	P	G	Cool, $4^{o}C$	Cool, $4^{o}C$	14 days
Ammonia	P	G	Cool, $4^{o}C$ H_2SO_4 to pH <2	Cool, $4^{o}C$	28 days
Asbestos	P	G	Cool, $4^{o}C$	Cool, $4^{o}C$	48 hours[f]
Bicarbonate	P	G	None Required	None Required	Analyze Immediately
Biochemical Oxygen Demand (BOD) and Carbonaceous BOD	P	G	Cool, $4^{o}C$	Cool, $4^{o}C$	48 hours
Bromide	P	G	None Required	None Required	28 days
Carbonate	P	G	None Required	None Required	Analyze Immediately
Chemical Oxygen Demand (COD)	P	G	Cool, $4^{o}C$ H_2SO_4 to pH <2	Cool, $4^{o}C$	28 days
Chloride	P	G	None Required	None Required	28 days
Chlorine, Total Residual	P	N/A	None Required	N/A	Analyze Immediately
Color	P	N/A	Cool, $4^{o}C$	N/A	48 hours
Cyanide, Total and Amenable to Chlorination	P	G	Cool, $4^{o}C$ NaOH to pH >12 0.6 g Ascorbic Acid[g]	Cool, $4^{o}C$	14 days [h]
Dissolved Oxygen					
Probe	G Bottle and Top	N/A	None Required	N/A	Analyze Immediately
Winkler	G Bottle and Top	N/A	Fix On Site Store in Dark	N/A	8 hours
Fluoride	P	G	None Required	None Required	28 days
Hardness	P	N/A	HNO_3 or H_2SO_4 to pH<2	N/A	6 months
Hydrazine	P	G	If not analyzed immediately, collect under acid. Add 90 ml of sample to 10 ml HCl.	Cool, $4^{o}C$	7 days
Iodide	P	G	Cool, $4^{o}C$	Cool, $4^{o}C$	24 hours
Iodine	P	G	None Required	None Required	Analyze Immediately
Kjeldahl and Organic Nitrogen	P	G	Cool, $4^{o}C$ H_2SO_4 to pH <2	Cool, $4^{o}C$	28 days

Table 1 (Cont'd.)

Parameter	Container[b] Water	Container[b] Soil	Preservative[c,d] Water	Preservative[c,d] Soil	Maximum Holding Time for all Matrices[e]
Metals[i]					
Chromium VI	P	G	Cool, 4°C	Cool, 4°C	24 hours
Mercury	P	G	HNO_3 to pH <2	Cool, 4°C	28 days
Others	P	G	HNO_3 to pH <2	Cool, 4°C	6 months
Nitrate	P	G	Cool, 4°C	Cool, 4°C	48 hours
Nitrate plus Nitrite	P	G	Cool, 4°C H_2SO_4 to pH <2	Cool, 4°C	28 days
Nitrite	P	G	Cool, 4°C	Cool, 4°C	48 hours
Oil and Grease	G	G	Cool, 4°C H_2SO_4 to pH <2	Cool, 4°C	28 days
Orthophosphate	P	G	Filter Immediately Cool, 4°C	Cool, 4°C	48 hours
pH	P	G	None Required	None Required	Analyze Immediately
Phenols	G	G	Cool, 4°C H_2SO_4 to pH <2	Cool, 4°C	28 days
Phosphorous, Elemental	G	G	Cool, 4°C	Cool, 4°C	48 hours
Phosphorous, Total	P,G	G	Cool, 4°C H_2SO_4 to pH <2	Cool, 4°C	28 days
Silica, Dissolved or Total	P	G	Cool, 4°C	Cool, 4°C	28 days
Residue					
Filterable	P	N/A	Cool, 4°C	N/A	7 days
Settleable	P	N/A	Cool, 4°C	N/A	48 hours
Nonfilterable (TSS)	P	N/A	Cool, 4°C	N/A	7 days
Total	P	N/A	Cool, 4°C	N/A	7 days
Volatile	P	N/A	Cool, 4°C	N/A	7 days
Specific Conductance	P	G	Cool, 4°C	Cool, 4°C	28 days
Sulfate	P	G	Cool, 4°C	Cool, 4°C	28 days
Sulfide	P	G	Cool, 4°C Add Zinc Acetate plus NaOH to pH >9	Cool, 4°C	7 days
Sulfite	P	G	None Required	None Required	Analyze Immediately
Surfactants	P	G	Cool, 4°C	Cool, 4°C	48 hours
Temperature	P	G	None Required	None Required	Analyze Immediately
Turbidity	P	N/A	Cool, 4°C	N/A	48 hours
ORGANIC TESTS[j]					
Acrolein and Acrylonitrile	S	S	Cool, 4°C 0.008% $Na_2S_2O_3$[g] Adjust pH to 4-5[k]	Cool, 4°C	14 days[k]

Parameter	Container[b] Water	Container[b] Soil	Preservative[c,d] Water	Preservative[c,d] Soil	Maximum Holding Time for all Matrices[e]
Benzidines[l]	G	G	Cool, $4^{\circ}C$[m] 0.008% $Na_2S_2O_3$[g] pH 2-7	Cool, $4^{\circ}C$	7 days until extraction
Chlorinated Hydrocarbons[l]	G	G	Cool, $4^{\circ}C$	Cool, $4^{\circ}C$	7 days until extraction 40 days after extraction
Haloethers[l]	G	G	Cool, $4^{\circ}C$ 0.008% $Na_2S_2O_3$[g]	Cool, $4^{\circ}C$	7 days until extraction 40 days after extraction
Nitroaromatics and Isophorone[l]	G	G	Cool, $4^{\circ}C$ Store in Dark	Cool, $4^{\circ}C$ Store in Dark	7 days until extraction 40 days after extraction
Nitrosamines[l,o]	G	G	Cool, $4^{\circ}C$ Store in Dark 0.008% $Na_2S_2O_3$[g]	Cool, $4^{\circ}C$ Store in Dark	7 days until extraction 40 days after extraction
PCBs	G	G	Cool, $4^{\circ}C$	Cool, $4^{\circ}C$	7 days until extraction 40 days after extraction
Pesticides[l]	G	G	Cool, $4^{\circ}C$ pH 5-9[p]	Cool, $4^{\circ}C$	7 days until extraction 40 days after extraction
Phenols[l]	G	G	Cool, $4^{\circ}C$ 0.008% $Na_2S_2O_3$[g]	Cool, $4^{\circ}C$	7 days until extraction 40 days after extraction
Phthalate Esters[l]	G	G	Cool, $4^{\circ}C$	Cool, $4^{\circ}C$	7 days until extraction 40 days after extraction
Polynuclear Aromatic Hydrocarbons[l]	G	G	Cool, $4^{\circ}C$ 0.008% $Na_2S_2O_3$[g] Store in Dark	Cool, $4^{\circ}C$ Store in Dark	7 days until extraction 40 days after extraction
Purgeable Aromatic Hydrocarbons	S	S	Cool, $4^{\circ}C$ 0.008% $Na_2S_2O_3$[g] HCl to pH<2[q]	Cool, $4^{\circ}C$	14 days[q]
Purgeable Halocarbons	S	S	Cool, $4^{\circ}C$ 0.008% $Na_2S_2O_3$[g]	Cool, $4^{\circ}C$	14 days
TCDD[l]	G	G	Cool, $4^{\circ}C$ 0.008% Na_2SO_3[g]	Cool, $4^{\circ}C$	7 days until extraction 40 days after extraction
Total Organic Carbon	G	G	Cool, $4^{\circ}C$ HCl or H_2SO_4 to pH <2	Cool, $4^{\circ}C$	28 days
Total Organic Halogen	G	G	Cool, $4^{\circ}C$ 1 ml of 0.1 M sodium sulfite	Cool, $4^{\circ}C$	7 days

Analytes not listed should be preserved at $4^{\circ}C$ and held not longer than 7 days.

[a]Preservatives and holding times are from Federal Register, Vol. 49, No. 209, Friday, October 26, 1984, Page 43260 and Characterization of Hazardous Waste Sites: A Methods Manual -- Volume II, Sampling Methods, Second Edition, EPA-600/4-84-076. Container requirements are consistent with these references.

[b]P = Polyethylene
G = Amber Glass with Teflon-lined cap
S = Glass Vial with Teflon-lined septum cap

[c]Sample preservation should be performed immediately upon sample collection. For composite samples, each aliquot should be preserved at the time of collection. When use of an automatic sampler makes it impossible to preserve each aliquot, samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.

[d]When any sample is to be shipped by common carrier or sent through the U.S. Mail, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring such compliance. For the preservation requirements in this table, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation, has determined that the Hazardous Materials Regulations do not apply to the following materials: Hydrochloric acid (HCl) in water solutions at concentrations of 0.04% by weight or less (pH about 1.96 or greater); Nitric acid (HNO_3) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H_2SO_4) in water solutions at concentrations of 0.35% by weight or less (pH about 1.15 or greater); and Sodium hydroxide (NaOH) in water solutions at concentrations of 0.080% by weight or less (pH about 12.3 or less).

[e]Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid.

Some samples may not be stable for the maximum time period given in the table. A laboratory is obligated to hold the sample for a shorter time if knowledge exists to show this is necessary to maintain sample integrity.

[f]If samples cannot be filtered within 48 hours, add 1 ml of a 2.71% solution of mercuric chloride to inhibit bacterial growth.

[g]Should only be used in the presence of residual chlorine.

[h]Maximum holding time is 24 hours when sulfide is present. Optionally, all samples may be tested with lead acetate paper before pH adjustment in order to determine if sulfide is present. If sulfide is present, it can be removed by addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and then NaOH is added to pH 12.

[i]For dissolved metals, filter immediately on site before adding preservative.

[j]Guidance applies to samples to be analyzed by GC, LC, or GC/MS for specific compounds.

[k]The pH adjustment is not required if acrolein will not be measured. Samples for acrolein receiving no pH adjustment must be analyzed within three days of sampling.

[l]When the extractable analytes of concern fall within a single chemical category, the specified preservative and maximum holding times must be observed for optimum safeguard of sample integrity. When the analytes of concern fall within two or more chemical categories, the sample may be preserved by cooling to 4°C, reducing residual chlorine with 0.008% sodium thiosulfate, storing in the dark, and adjusting pH to 6-9; samples preserved in this manner may be held for 7 days before extraction and 40 days after extraction. Exceptions to this optimal preservation and holding time procedure are noted in footnotes g, m, and n.

[m]If 1,2-diphenylhydrazine is likely to be present, adjust the pH of the sample to 4.0 ± 0.2 to prevent rearrangement to benzidine.

[n]Extracts may be stored up to 7 days before analysis if storage is conducted under an inert (oxidant-free) atmosphere.

[o]For the analysis of diphenylnitrosamine, add 0.008% $Na_2S_2O_3$ and adjust pH to 7-10 with NaOH within 24 hours of sampling.

[p]The pH adjustment may be performed upon receipt at the laboratory and may be omitted if the samples are extracted within 72 hours of collection. For the analysis of aldrin, add 0.008% $Na_2S_2O_3$.

[q]Sample receiving no pH adjustment must be analyzed within 7 days of sampling.

INSTALLATION OF GROUNDWATER MONITORING WELLS

INTRODUCTION

The installation of monitoring wells at JPG will be on the basis of findings of the other field investigation activities scheduled which include soil gas, surface soil, and subsurface soil sampling. If the need for additional wells is determined from collected data, placement of the wells will also be guided by the results of geophysical surveys and previous hydrological surveys.

SCOPE

This procedure outlines the methods to be used at JPG for the installation of monitoring wells at JPG with emphasis on satisfying the Data Quality Objectives and USATHAMA Geotechnical Requirements (Appendix B of the Sampling Design Plan).

SIGNIFICANCE AND USE

Specifically, the objectives of the monitoring well installations at JPG will be to:

- Provide initial data on the horizontal and vertical extent of groundwater contamination at specific sites at JPG.
- Identify potential source areas for groundwater contamination at JPG.
- Characterize the hydrologic flow regime including flow direction, flow rate, flow gradient, etc.

DRILLING TECHNIQUES

All drilling equipment will be steam cleaned prior to entering the JPG site and again prior to use at a specific monitoring well location. All water used will be from a USATHAMA-approved source.

The hollow-stem auger drilling rig used for soil boring activities at JPG will be used to advance the well borehole to bedrock. Nominal size 9 5/8-inch O.D. x 6 1/4-inch I.D. hollow stem augers with a retrievable center bit or flexible plug will be used to drill to the bedrock. A plastic "diaper" will be used to cover the ground surface around the borehole. All cuttings will be transferred from the ground cover to 55-gallon drums.

Once bedrock is reached, mud-rotary drilling (mixture of approved water and pure Wyoming bentonite as circulating fluid) will be used with the same drill rig to drill the hole to total depth. The wells will first be cored from the top of the bedrock to the total depth to allow proper logging of subsurface stratigraphy. These cores will be boxed and logged according to USATHAMA Geotechnical Requirements. Once coring has been completed, the hole will be reamed to the proper diameter (approximately 10 inch diameter hole) for well installation.

All cuttings-rich drilling mud will be directed to a mud tank where the drilling fluids will be screened and the cuttings removed and placed in 55-gallon drums.

Each well borehole will be fully logged utilizing a boring log which records and classifies the lithology and stratigraphy encountered. The procedures to be followed are also described in the USATHAMA Geotechnical Requirements (Appendix B of the Sampling Design Plan). Logging will include:

- Soil descriptions according to the Unified Soil Classification System
- Amount of recovery for drive samples
- Amount of recovery for rock cores
- Blow counts for drive samples
- Depth to water
- Depth of any samples taken
- Type and amount of drilling fluids used
- Description of the drilling equipment used
- Name of the drilling company and names of personnel
- Well ID information including Site, Location, Well ID Number
- Date(s) of start and completion

MONITORING WELL INSTALLATION

All well installations will begin within 48 hours of boring completion. Once the process of well installation begins, it will continue until installation is completed. Although each boring may be unique, the following standard installation procedures will be followed according to USATHAMA Geotechnical Requirements (Appendix B of the Sampling Design Plan).

1. Steam-clean all well screen and casing prior to installation. Keep cleaned materials wrapped in clean plastic to prevent inadvertent contamination of well materials.

2. Measure the total depth of the well and determine the proper amount of blank casing and well screen.

3. Using a standard 4-inch diameter (ID) Schedule 40 PVC (shallow wells) or Schedule 80 PVC threaded casing and 10 foot long screen with a slot width of 0.010 inch, assemble the drill string, including a screw-on bottom cap or plug. In deeper holes, centering devices may be required to hold the well string in the central portion of the hole. Sufficient riser must be added to allow a 2.5 foot stick-up from ground surface.

4. Lower the drill string to the bottom of the hole. Measure the amount of stickup to determine if any loss of hole depth occurred as a result of hole caving, flowing sands, etc.

5. Using a tremie pipe, install an approved sand pack from the bottom of the hole to 5 feet above the well screen.

6. Install a 5-foot-thick bentonite seal using bentonite pellets on top of the sand pack and allow the pellets to hydrate for approximately two hours.

7. Mix a cement-bentonite grout mixture (20 parts Portland Type II or V cement to one part bentonite using a maximum of 8 gallons of approved water per bag of bentonite) and, using a tremie pipe, grout to within 2 feet of the surface.

8. Install a 6-inch diameter protective steel casing over the PVC riser and fill the remaining 2 feet of the hole with concrete.

9. After allowing grout to set for 24 hours, recheck for settling and add cement as needed.

10. Protective posts and a coarse gravel or concrete pad will be placed around the protective casing to allow drainage away from the well and to protect the well from damage (i.e., vehicular traffic). The protective casing and protective posts will be painted with an orange, high-visibility paint, and the well ID number will be permanently marked on the protective casing (i.e., welded on).

WELL DEVELOPMENT

INTRODUCTION

Well development serves to remove the finer grained material from the well screen and filter pack that may otherwise interfere with water quality analyses, restore the groundwater properties disturbed during the drilling process, and to improve the hydraulic characteristics of the filter pack and hydraulic communication between the well and the hydrologic unit adjacent to the well.

SCOPE

This procedure provides a description of the most commonly used methods of well development, including mechanical surging and bailing or pumping. Due to the depths of the wells at JPG, surging and pumping will most likely be used.

SIGNIFICANCE AND USE

An important factor in any development method is that the development work be started slowly and gently and be increased in vigor as the well is developed. Most methods of well development require the application of sufficient energy to disturb the filter pack, thereby freeing the fines and allowing them to be drawn into the well for removal. The coarser fractions settle around and stabilize the screen.

PROCEDURE

The preferred method to be used at JPG will be the mechanical surge block technique. In this method, water will be forced to flow into and out of the well screen by operating a plunger (surge block) or bailer up and down the riser. A pump will be used to remove all dislodged materials.

Well development will begin no sooner than 48 hours after well completion, but no longer than 7 days after. Once development has begun, the procedure will be continued until all of the following criteria are met:

- The well water is clear to the unaided eye.
- The sediment thickness remaining within the well is less than 1% of the screen length.
- Five times the measured amount of total fluids lost while drilling plus five times the combined amount of standing water, annular water, and that used in filter pack placement are removed.

NOTE: If the well yield cannot sustain flow using a submersible pump, a bailer may have to be used.

DOCUMENTATION

The following information will be completed for each well developed:

- Date of development
- Static water level before, and 24 hours after, development
- Quantity of water loss during drilling and fluid purging
- Quantity of standing water in the well and annulus prior to development
- Specific conductivity, temperature, and pH measurements taken at the start of development, during development, and at the conclusion of development.
- Total depth of well (measurement before development, and one after, from top of casing to bottom of well)
- Description of water quality during development (color, amount of particulates, odor, etc.)
- Description of technique used
- Total quantity of water removed
- Names of personnel performing the development

AQUIFER TESTING

INTRODUCTION

Aquifer testing will be performed on newly installed wells at JPG to measure the hydraulic conductivity of the aquifer in which the wells have been installed.

SCOPE

All new monitoring wells will be tested using the slug-withdrawal method for determining hydraulic conductivity. This procedure provides a relatively simple method for calculating hydraulic conductivity in a single well. A sufficient number of monitoring wells do not exist presently at JPG to perform multiple well tests (pumping tests).

APPARATUS

The test apparatus will consist of a sealed, weighted bailer with a known water displacement volume and an electric pressure transducer connected to an automatic electronic data logger. The bailer support line and pressure transducer cable will be marked to allow proper positioning in the well.

PROCEDURE

1. With an electronic sounder or interface probe, measure the static water level in the well and record in terms of feet below the top of the casing.

2. Lower the transducer to a position 6 inches above the bottom of the well casing and tape the cable to the exterior of the casing at the top of the well to hold the transducer in position. Record the transducer reading displayed on the data logger.

3. Lower the bailer until totally submerged, with the top of the bailer 6 inches below the static water level.

4. Monitor the water level until the well stabilizes (the data logger reading returns to the value recorded prior to inserting the bailer).

5. Set the recording level on the logger to CONTINUOUS.

6. Rapidly and smoothly lift the bailer out of the water column and remove the bailer assembly from the monitor well. Decontaminate the bailer and support line with clean, approved water rinse and a distilled water rinse.

7. After the bailer is lifted out of the fluid, the recorder will record continuously for 5 minutes.

8. At 5 minutes, set recording interval to 30 seconds and record for 5 minutes.

9. At 10 minutes, set recording interval to 1 minute.

10. At 20 minutes, set recording interval to 2 minutes.

11. At 40 minutes, set recording interval to 5 minutes.

12. At 2 hours, set the interval to 10 minutes and maintain until the water-level recovery rate becomes negligible.

13. Upon completion of the test, the pressure transducer and support cable will be removed from the well and decontaminated using approved water rinse followed by distilled water rinse.

NOTE: The data at all intervals will be transferred into individual data files on a microcomputer from the logger. The first column of the file will be "time in seconds" and the second will be "hydraulic head in feet." A computer program will then be used to calculate the hydraulic conductivity from the slug test.

SOIL GAS SAMPLING

INTRODUCTION

Soil gas surveys are often performed to delineate areas of potential contamination and to evaluate the effectiveness of a remedial action process at hazardous waste sites. Samples are collected from hollow probes inserted into the soil at a pre-determined sampling depth. For screening areas of potential contamination, sample probes can be rapidly installed up to 20 feet in ideal soils. Sample probes can also be left in place for subsequent sample collecting if long-term monitoring is required.

SCOPE

This procedure is intended to provide a method for the measurement of soil gas in near-surface soils. Procedures are provided for the installation of probes either manually or with a hydraulically powered system.

SIGNIFICANCE AND USE

Small diameter hollow probes inserted several feet below the surface of the ground are used to collect soil-gas samples. Probes can be inserted by manually driving the probe with a slide hammer or pressing the probe into the soil with a hydraulically powered mechanical system. For shallow sampling (4 feet or less), manual probing is preferred because of the ease and speed of obtaining samples. Difficult topographic access areas restricting the use of power equipment preclude the use of the hydraulic system. Deep sampling (over 4 feet) or when it is necessary to penetrate a cover (i.e., asphalt) will generally require the use of the hydraulically powered system.

APPARATUS

Manual Probe:

- Six-feet-long, hollow, steel sample probes
- Three-pound slide hammer or fence post driver
- Expendable drive points
- Retainer disk
- Sample manifold
- Cylinder of ultra-pure ambient monitoring air
- Regulator to fit ultra-pure ambient monitoring air cylinder
- Protective equipment, including steel-toed boots, safety glasses, ear protection, and leather gloves.

Hydraulic Powered Probe

- Geoprobe Hydraulic Hammer-Drill (or equivalent) mounted in the rear of a cargo van or 4WD vehicle
- Wire brush
- Fuses
- Three-feet-long sections of drill rods with conventional threads
- Drive and pull caps
- Hammer anvil and drive point holder
- Carbide-tipped drill bit to penetrate asphalt
- Expendable drive points
- Soil-gas sampling cap
- Cylinder of ultra-pure ambient monitoring air
- Regulator to fit ultra-pure ambient monitoring air cylinder
- Appropriate safety equipment, including steel-toed shoes, safety glasses, ear protection, leather gloves

PROCEDURE

Installation - Manual Probe

1. Obtain proper work permits for subsurface intrusion, locate specific sampling sites, and clear for utilities and UXO as required.

2. Place an expendable drive point into the non-threaded end of the sample probe.

3. Place the end of the drive point on the marked sample location and, using a slide hammer, drive the probe to the desired sample depth (generally 4 feet). Use of a retaining disk on the top of the probe serves as a safety measure to insure that the hammer does not separate from the probe during installation, which could cause serious injury.

4. By reversing the motion (pounding upward), pull the probe from 4 to 6 inches up to allow a cavity from which a sample can be drawn.

5. Remove the retaining ring and thread the sampling manifold to the top of the probe.

6. Flush the sample probe with ultra-pure air at a rate of 2 liters per minute for 30 seconds.

Hydraulically Powered Sample Probe

1. Obtain work permits as required, mark sample locations, and perform utility and UXO surveys.

2. Position the vehicle so that the hydraulic ram is directly over the sampling point.

3. Set the vehicle brake and chock wheels.

4. Engage the hydraulic system and extend the hydraulic ram and rotate to a vertical position. Lower the foot to the ground surface and turn off the hydraulics.

5. Insert the hammer anvil into the drill and secure with the hammer latch. Make sure that the hammer rotation control is in the middle position, indicating no rotation.

6. Prepare the probe by inserting an expendable tip into the lower end of the probe and screwing a drive cap on the top end of the probe.

7. Turn the hydraulic switch to the middle position and raise the ram far enough to stand the probe in a vertical position under the hammer anvil. Carefully lower the ram, guiding the probe into the recess in the hammer anvil.

8. Pull the hydraulic lever to slowly lower the ram to press the probe into the soil. Use the hammer only if necessary.

9. Press or hammer the probe to the desired sampling depth, then remove the drive cap and screw on the soil-gas sampling cap to the top of the probe.

10. Purge the probe with ultra-pure air at a rate of 2 liters per minute for 30 seconds.

NOTE: Due to the physical hazards associated with the hydraulically driven probes, only qualified and experienced operators will be used to conduct the driving of sample probes.

SAMPLING PROCEDURE

Several types of sampling methods may be used for the collection of soil gas samples. These include direct measurements through a PID, direct sampling using indicator tubes, samples collected in bags, glass bulbs, and syringes for on-site GC analysis, or samples collected in vacuum canisters or sorbent tubes for off-site laboratory analysis. The preferred method for rapid on-site analysis is the use of sample containers for transfer to an on-site portable GC for analysis.

1. Purge the probe of ambient air using the ultra-pure air or evacuate using a hand-operated vacuum pump.

2. Depending on the type of apparatus used, allow the sample container to fill with soil gas from within the probe. For glass bulbs with stopcocks, open the stopcock connected to the vacuum pump and pump the air out of the bulb, then close the stopcock. Open the other stopcock to draw vapor from the sample probe, then close. With both stopcocks closed, the sample can be transferred to the on-site GC for

analysis by connecting to the bulb and opening a stopcock. Pedlar bags may be used with the same basic procedure of evacuation and trapping of soil gas in the bag by the use of a valve. A syringe may be used where the syringe is inserted into a septum located between the vacuum pump and the probe. Once inserted, the sample is withdrawn by pulling out on the syringe handle. The syringe is then transferred to the portable GC where the soil gas is inserted by pushing in on the syringe plunger.

3. Using gas standards for the analytes of interest, normally BTEX, calibrate the portable GC prior to sampling and again after every 2 to 5 samples depending on sample concentrations found.

4. Soil gas can first be checked by inserting a portion of the sample into a PID to determine relative concentrations to avoid damaging the GC in the case of high concentrations.

5. Operate the portable GC according to the Standard Operating Procedures for the specific instrument and model.

6. Record all required information on a sample log sheet and/or field logbook. This includes sample ID number, sample location, sample depth, date, time of sampling, atmospheric conditions, amount of air purged, and GC results.

GEOPHYSICAL SURVEYS

INTRODUCTION

Two types of geophysical surveys have been proposed for the RI at JPG. These are magnetometer and ground-penetrating radar (GPR) surveys. Several types of geophysical systems are commercially available to perform these surveys. Selection of specific instruments will not be part of this procedure. Instrument-specific operating procedures must be consulted for procedures on calibration and operation.

SCOPE

The procedure described here is general in nature. Due to the complex nature of geophysical surveying, only personnel trained and experience in geophysical surveys will be used. There are other types of geophysical surveys that could be used at JPG. The two selected appear to have the greatest potential for yielding the desired information, which is chiefly the location of buried trenches, pits, and landfills that potentially contain materials hazardous to human health of the environment.

SIGNIFICANCE AND USE

Magnetometer (or Magnetic Gradiometer) surveys are possibly the best techniques currently available for locating buried drums, underground tanks, pipes, and buried metal debris (i.e., buried paint containers, pesticide containers, UXO). Ground penetrating radar has the ability of providing "image" type displays of data from reflected energy from subsurface targets. This technique is useful in helping define the boundaries between disturbed deposits (i.e., filled trench) and surrounding undisturbed deposits (natural soils or geologic horizons). Used in combination, these two techniques will be useful in locating and defining former disposal sites at JPG.

APPARATUS

- Radar system equipped with a 500-megahertz antenna. System includes a power distribution unit, a radar signal generator/transmitter with trolling cart, a microprocessor, and an output device (chart or tape recorder).

- Magnetometer/Gradiometer System consisting of top and bottom sensors, connecting bar and brace, pole sections, console and cycling switch, base station, sensor, console, and battery pack.

PROCEDURE

GPR:

1. Establish the desired grid system and spacing.

2. Pull the light-weight radar vehicle (cart) by hand, or tow behind a vehicle at slow speeds.

3. Monitor the response in the equipment van. The data is also recorded on tape.

4. Employ a processing routine in the central system to reduce/eliminate signal noise; playback from the tape with microprocessor modification of signals to achieve on-site enhancements.

Magnetometer:

1. Establish survey grid.

2. Remove all personal magnetic objects from personnel.

3. Set up and calibrate system according to manufacturer's operating procedures.

4. Select a background location as a calibration check and baseline reference measurement point.

5. Assemble the base station, orient the sensor north-south, and erect the sensor staff. Connect the sensor cable to the magnetometer console box.

6. Determine and record the geomagnetic field inclination and determine the direction of magnetic north. Perform instrument standardization procedures.

7. Once instruments are standardized, begin collecting readings of the magnetic field intensity with the field survey magnetometer at two vertically separated points at each observation grid. By keeping the sensors elevated and oriented north-south, interference from small magnetic items at the surface is reduced relative to larger buried sources. Remain stationary until the magnetometer has read and stored the readings.

8. Record date and time of survey, survey area, operator's name, line number, start station on surveyed line, beginning reading for the surveyed line, and ending reading number for the surveyed line.

9. Repeat readings at each grid station.

STANDARD PRACTICE FOR THE SAMPLING OF LIQUIDS

INTRODUCTION

The type of sampling equipment used for sampling liquids at JPG will depend on the sample to be collected, which analytes the sample is being collected for, and the site-specific requirements such as depth to water, depth of well, etc. Because each sampling situation is unique, the equipment used and its application may have to be modified to ensure that a representative sample is collected and its physical and chemical integrity is maintained.

SCOPE

The procedures listed here are used to collect liquid samples. There are several methods that can be used to collect liquid samples. Some sampling situations use a combination of these methods. For example, a peristaltic pump could be used to collect the inorganic samples and a bailer used to collect the organic samples. The methods likely to be used at JPG are:

- Sampling with a Peristaltic Pump
- Sampling with a Bladder Pump
- Sampling with a Bailer
- Sampling with a Submersible Pump
- Sampling by Container Immersion

SIGNIFICANCE AND USE

The usefulness and limitations for each of the first four sampling methods are described as follows:

Peristaltic Pump:

APPENDIX B

GEOTECHNICAL REQUIREMENTS

FOR

DRILLING, MONITOR WELLS, DATA ACQUISITION, AND REPORTS

MARCH 1987

DEPARTMENT OF THE ARMY

U.S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY

ABERDEEN PROVING GROUND, MD 21010-5401

D I S C L A I M E R

The views, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision unless so designated by other documentation.

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III.

I. OBJECTIVE.

The objective of these requirements is to set forth the geotechnical criteria and procedures of the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA). These requirements are used in technical support of the Contracting Officer for geotechnical exploration and reporting. The application of geotechnology to environmental programs should begin with project conception. The Geotechnical Requirements join this application during the design of the field program, after the initial magnitude of the study has been determined and tentative well sites selected. The application of these requirements is intended to provide acceptable technical data and tracking procedures to accurately obtain, describe, and evaluate representative samples of the subsurface environment in terms of geology, hydrology, and groundwater chemistry. This sample-specific data can be merged with site-operational knowledge to characterize and appraise the contaminant potential of the site.

II. GENERAL POLICY.

A. The Geotechnical Requirements shall be a part of and attached to each Request for Proposal or Quotation (RFP/RFQ) involving subsurface exploration and resulting contracts and/or task orders. A verbatim copy of these Requirements, modified by only the initial contract or task order and subsequent amendments, shall be made part of and attached to the contractor's Technical Plan (or equivalent document).

B. The Geotechnical Requirements were written as a generalized document. Application to a specific contract or task is likely to generate obvious or subtle conflicts. When conflicts exist between the Geotechnical Requirements and specific contractual documents; i.e., the RFP/RFQ, contract, task order, or contractual amendments, the latest contractual documents shall take precedence.

C. Technically, the Contracting Officer is the only Governmental agent who has the authority to change a given contract. Some administrative aspects of this authority are usually delegated in writing to certain USATHAMA personnel serving as Contracting Officer's Representatives (COR). These aspects include the approval for use of specified items; e.g., the drilling water, granular filter pack, bentonite, etc., as discussed in the Geotechnical Requirements. USATHAMA's approval of these items is performed through and under the authority of the Contracting Officer. Therefore, the contractor's requests for approval of, variance from, or notification of problems with the technical items within these Geotechnical Requirements shall be directly sent from the contractor to the USATHAMA COR responsible for that contract or task.

D. Any deviation from the contract shall be requested of and approved by the Contracting Officer. Deviations approved for a given contract or task shall not be applicable to any other contract or task unless specified in the approval.

E. These requirements will be updated as required incorporating new technology, experience, and policy.

III. SPECIFIC ELEMENTS.

A. Drilling Operations.

1. Drilling Methods.

a. The object of drilling method selection is to use that technique which:

(1) Minimizes subsurface contamination or cross contamination.

(2) Provides representative data.

(3) Minimizes drilling costs.

b. To this end, the following drilling methods are typically used:

(1) Hollow-stem augers.

(2) Water/mud rotary.

(3) Cable tool/churn drill.

(4) Air rotary.

c. Of these, air rotary is the least desirable and is further discussed in section III.A.2. Other methods, like reverse circulation, may have applicability in certain cases. Unless specified in the RFP/RFQ, the drilling method shall be suggested and described by the contractor in his RFP/RFQ response and/or technical plan, for the Contracting Officer's consideration and approval.

2. Air Rotary.

a. Air systems, including bottled gas, shall not be used for drilling, well installation, well development, presample purging, or sampling unless specified in the statement of work. However, when alternative bids or proposals are allowed, the contractor may present as part of the bid/proposal package an alternative using an air system(s) for a given operation(s). The contractor's alternative shall include:

(1) Situation.

(2) Recommendation.

(3) The effect of usage upon groundwater and soil chemical analyses.

(4) Alternatives with cost savings or increases, as appropriate.

b. The above item shall be quantified, costed (in the appropriate section of the bid/proposal package), and shall incorporate the

appropriate criteria discussed in paragraph III.A.2.c. below. Consideration and a recommendation by USATHAMA will be made during the course of bid/proposal evaluation, prior to contract award.

c. In general, air system plans shall:

(1) Specify the type of air compressor and lubricating oil and require a pint sample of each oil be retained by the contractor, along with a record of oil loss (on the boring log), for evaluation in the event of future problems. The oil sample(s) may be disposed of upon contract/task completion.

(2) Require an air line oil filter and that the filter be changed per manufacturer's recommendation during operation with a record kept (on the boring log) of this maintenance. More frequent changes shall be made if oil is visibly detected in the filtered air.

(3) Prohibit the use of any additive except approved water (III.A.10.b.) for dust control and cuttings removal.

(4) Detail the use of any downhole hammer/bit with emphasis upon those procedures to be taken to preclude residual groundwater sample contamination caused by the lubrication of the downhole equipment.

d. Air usage shall be fully described in the log or associated geotechnical report to include equipment description(s), manufacturer(s), model(s), air pressures used, frequency of oil filter change, and evaluations of the system performance, both design and actual.

3. Recirculation Tanks and Sumps. Portable recirculation tanks are suggested for mud/water rotary operations and similar requirements. The use of dug sumps/pits (lined or unlined) is expressly prohibited.

4. Site Geologist. A geologist shall be present and responsible at each operating drill rig for the logging of samples, monitoring of drilling operations, recording of water losses/gains and groundwater data, preparing the boring logs and well diagrams, and recording the well installation procedures of that rig. Each geologist shall be responsible for only one operating rig. Each geologist shall have onsite sufficient tools and professional equipment in operable condition to efficiently perform his/her duties as outlined in these Geotechnical Requirements and other contractual documents. Items in the possession of each geologist shall include, as a minimum: a copy of the geotechnical portion of the statement of work, the USATHAMA-approved Technical Plan (or equivalent) which incorporates these Geotechnical Requirements, the approved Safety Plan (approved after contract award), a 10X (minimum) hand lens, and a weighted (with steel or iron) tape(s), long enough to measure the deepest well within the contract, heavy enough to reach that depth, and small enough to readily fit within the annulus between the well and drill casing. Each geologist shall also have onsite a water level measuring device, preferably electrical.

5. Permits, Rights-of-Entry, and Licenses. The contractor shall be responsible for securing and complying with any and all boring or well drilling permits and/or procedures required by state or local authorities and

for determining and complying with any and all state or local regulations with regard to the submission of well logs, samples, etc. Submission of these items to state or local authorities shall be coordinated through USATHAMA. The contractor shall telephonically notify USATHAMA immediately in the event of any apparent discrepancy between contractual and state or local requirements. Notification shall include the nature of the discrepancy; the name, agency, and telephone number of the person noting the discrepancy; and the current status. Any rights-of-entry (for off-post drilling) will be obtained for and supplied to the contractor by the Contracting Officer. The contractor shall ensure that all drilling of boreholes, well installation, and topographic surveying is accomplished by companies appropriately licensed in the project State. A copy of each current license (denoting expiration date) shall be provided in the contractor's Technical Plan. If the project State does not require a licensed driller for this project, then a statement to that effect shall be included in the technical plan.

6. Drilling Safety and Underground Utility Detection. The contractor shall be responsible for determining and complying with any and all (to include host installation) regulations, requirements, and permits with regard to drilling safety and underground utility detection. The contractor shall include a discussion of his actions with regard to these items in his proposal and Safety Plan (also see III.A.12.b., III.A.12.d., and III.G.).

7. Lubricants. Only petroleum jelly, teflon tape, lithium grease, or vegetable-based lubricants shall be used on the threads of downhole drilling equipment. Additives containing lead or copper shall not be used. Any hydraulic or other fluids in the drilling rig, pumps, or other field equipment/vehicles shall NOT contain any polychlorinated biphenyls (PCBs).

8. Surface Runoff. Surface runoff; e.g., precipitation, wasted or spilled drilling fluid, and miscellaneous spills and leaks, shall not enter any boring or well either during or after drilling/well construction. To help preclude this, the use of starter casing, recirculation tanks, berms about the borehole, and surficial bentonite packs, as appropriate, are suggested.

9. Antifreeze. If antifreeze is added to any pump, hose, etc., in an area in contact with drilling fluid, this antifreeze shall be completely purged prior to the equipment's use in drilling, mud mixing, or any other part of the overall drilling operation. Only antifreeze without rust inhibitors and/or sealants shall be used. The contractor shall note on the boring log the dates, reasons, quantities, and brand names of antifreeze per above.

10. Materials.

a. Bentonite is the only drilling fluid additive allowed. No organic additives shall be used. Exception is usually made for some high yield bentonites to which the manufacturer has added a small quantity of polymer. The use of any bentonite must be approved by the Contracting Officer prior to the arrival onsite of the drilling equipment (rigs). This includes bentonites (powders, pellets, etc.) intended for drilling mud, grout, seals, etc. The following data, III.A.10.a.(1)-(5), shall be submitted in writing (see Figure 1) through USATHAMA to the Contracting Officer as part of the approval request. Allow six working days from the time of receipt by USATHAMA for request evaluation and recommendation.

III.A.10.a.

(1) Brand names(s).

(2) Manufacturer(s).

(3) Manufacturer's address(es) and telephone number(s).

(4) Product description(s) from package label(s)/manufacturer's brochure(s).

(5) Intended use(s) for this product.

b. Water.

(1) The source of any water to be used in drilling, grouting, sealing, filter placement, well installation, or equipment washing must be approved by the Contracting Officer prior to arrival of the drilling equipment onsite. Parameters for approval include:

(a) A deep aquifer origin (ideally, greater than 200 feet below ground surface).

(b) Well head upgradient of potential contaminant sources.

(c) Free of survey-related contaminants by virtue of pretesting (sampling and analysis) by the contractor using a laboratory certified by or in the process of being certified by USATHAMA for those contaminants. Pretesting shall be conducted on duplicate samples, each analyzed at a different time, using separate lots.

(d) The water to be non-treated and non-filtered.

(e) The tap to have 24-hour per day, 7-day per week access with plumbing sufficient to allow the filling of a 500 gallon tank in less than 20 minutes.

(f) The use of only one designated tap for access.

(2) Periodic testing of the approved water source may be required when the water is used to clean the sampling equipment after well installation. A detailed discussion of these requirements is provided in the USATHAMA Quality Assurance Program.

(3) Surface water bodies shall not be used, if at all possible.

(4) If a suitable source exists onsite, the contractor shall be directed to that source. If no onsite water is available, the contractor shall locate a potential source and submit the following data, III.A.10.b.(4)(a)-(h), in writing to USATHAMA (see Figure 2) for the Contracting Officer's approval prior to the arrival of any drilling equipment onsite. Allow three calendar weeks from the time of receipt by USATHAMA for request evaluation and recommendation.

(a) Owner/address/telephone number.

(b) Location of tap/address.

(c) Type of source (well, pond, river, etc.). If a well, specify static water level (depth), date measured, well depth, and aquifer description.

(d) Type of treatment and filtration prior to tap (chlorination, fluoridation, softening, etc.).

(e) Time of access (24-hours per day, 5-days per week, etc.).

(f) Cost per gallon charged by Owner/Operator.

(g) Results and dates of all available chemical analyses over past two years. Include the name(s) and address(s) of the analytical laboratory(s)

(h) Results and date(s) of duplicate chemical analysis (see III.A.10.b.(1)(c)) for project contaminants by a laboratory certified by or in the process of being certified by USATHAMA for those contaminants.

(5) The contractor has the responsibility to procure, transport, and store the water required for project needs in a manner to avoid the chemical contamination or degradation of the water once obtained. The contractor is also responsible for any heating, thermal insulation, or agitation of the water to maintain the water as a fluid for its intended uses.

(6) The contractor shall enter the chemical and geotechnical data for the approved water source into the Data Management System.

c. Grout.

(1) Materials. Grout, when used in monitor well construction or well abandonment, shall be composed by weight of 20 parts cement (Portland cement, type II or V) up to 1 part bentonite with a maximum of 8 gallons of approved water per 94 pound bag of cement. Neither additives nor borehole cuttings shall be mixed with the grout. Bentonite shall be added after the required amount of cement is mixed with water.

(2) Equipment. All grout materials shall be combined in an above-ground rigid container or mixer and mechanically (not manually) blended onsite to produce a thick, lump-free mixture throughout the mixing vessel. The mixed grout shall be recirculated through the grout pump prior to placement. Grout shall be placed using a grout pump and tremie. The grout pump for recirculation and placement shall be a commercially available product specifically manufactured to pump cement grouts. The tremie pipe shall be of rigid, not flexible, construction. Drill rods, rigid polyvinyl chloride (PVC) or metal pipes are acceptable tremies. Hoses and flexible PVC are unacceptable. Grout placement, via gravity and the grout head, using an elevated grout tank is expressly prohibited.

(3) Grout shall be placed in the monitor wells as follows:

(a) When a bentonite seal is used as shown in Figures 5 or 6:

(i) Prior to exposing any portion of the borehole above the seal by the removal of any drill casing (to include hollow-stem augers), the annulus between the well casing and drill casing shall be filled with grout.

(ii) The grout shall be placed from within a rigid tremie pipe, located just over the top of the seal.

(iii) The grout shall be pumped through this pipe to the bottom of the open annulus until undiluted grout flows from the annulus at ground surface, forming a continuous grout column from the seal to ground surface. The grout shall not penetrate the well screen or granular filter pack. Disturbance of the bentonite seal should be minimal.

(iv) The drill casing shall then be removed and more grout immediately added to compensate for settlement.

(v) If drill casing (to include hollow-stem auger) was not used, proceed with grouting to ground surface in one, continuous operation.

(vi) After 24 hours, the contractor shall check the site for grout settlement and that day add more grout to fill any settlement depression.

(vii) Repeat this process until firm grout remains at ground surface.

(viii) Incremental quantities of grout added in this manner shall be recorded as added and the data submitted to the Contracting Officer through USATHAMA on the well diagram (or addendum).

(b) When no bentonite seal is used (unusual occurrence requiring specific Contracting Officer approval):

(i) The contractor shall mix, place, monitor, and report grout usage as described above: III.A.10.c.(1) to (3)(a)(viii), but position the rigid tremie pipe just above the granular filter pack.

(ii) Place the grout so as to avoid grout penetration into the underlying granular filter pack and screen.

(4) If field conditions permit, the contractor may incrementally place grout and remove drill casing so as to constantly maintain 10 feet of grout (minimally) within the casing yet to be removed from the ground. Using this method requires at least 20 feet of grout to be within the casing before removing 10 feet of casing.

(5) For grout placement at depths less than ten feet in a hole, the grout may be poured in place from ground surface.

d. Granular Filter Pack. For this discussion, refer to section III.C.5.

e. Well Screens, Casings, and Fittings. For a discussion of these materials, see section III.C.2.

f. Well Caps and Centralizers. These items are discussed in sections III.C.3. and 4, respectively.

g. Well Protection. Elements of well protection are covered in section III.C.8.

h. Tracers, dyes, or other substances shall not be used or otherwise introduced into borings, wells, grout, backfill, groundwater, or surface water unless specifically required by contract.

i. Summarize the usage of these and any other drilling/well construction materials which potentially could have a bearing on subsequent interpretation of the analytical results. Include this summary within the geotechnical report. An example summary is provided at Table 1.

11. Abandonment. Abandonment is that procedure by which any boring well is permanently closed. Abandonment procedures shall preclude any current or subsequent discharges from entering the abandoned boring or well and thereby terminate access to the subsurface environment.

a. The abandonment of any borings or wells not scheduled for abandonment per contract, must be approved by the Contracting Officer prior to any casing removal, sealing, or backfilling. Abandonment requests shall be submitted telephonically through USATHAMA to the Contracting Officer with the following data, III.A.11.a.(1)-(3), plus recommendation. Allow four consecutive hours from the time of receipt by USATHAMA for request evaluation and decision. Frequently, resolution is made within minutes. Infrequent circumstances may preclude a four-hour resolution. A written followup memorandum shall be submitted by the contractor within five working days of the telephonic request. This document shall be forwarded through USATHAMA to the Contracting Officer and contain the following data:

(1) Designation of well/bore in question.

(2) Current status (depth, contents of hole, stratigraphy, water level, etc.).

(3) Reason for abandonment.

(4) Action taken, to include any replacement boring or well.

b. Each boring or well to be abandoned shall be sealed by grouting from the bottom of the boring/well to ground surface. This shall be done by placing a grout pipe to the bottom of the boring/well (i.e., to the maximum depth drilled/bottom of well screen) and pumping grout through this

pipe until undiluted grout flows from the boring/well at ground surface. Any open or ungrouted portion of the annular space between the well casing and borehole shall be grouted in the same manner also. Grout composition, equipment, and placement procedures are covered in section III.A.10.c.

c. After 24 hours, the contractor shall check the abandoned site for grout settlement. That day, any settlement depression shall be filled with grout and rechecked 24 hours later. This process shall be repeated until firm grout remains at ground surface.

d. Normally an abandoned well shall be grouted with the well screen and casing in place. However, a lack of data concerning well construction or other factors may dictate the removal of the well materials and a partial or total hole redrilling prior to sealing the well site.

e. For each abandoned boring/well, a record shall be prepared to include the following, III.A.11.e.(1)-(13), as applicable. Report all depths/heights from ground surface. The original record shall be submitted to USATHAMA within three working days after abandonment is completed.

(1) Boring/well designation.

(2) Location with respect to the replacement boring or well (if any); e.g., 20 feet north and 20 feet west of Well 14.

(3) Open depth prior to grouting and depth to which grout pipe placed. This includes the depth of open hole, open depth to the bottom of the well, and the open depth in the well-borehole annulus.

(4) Casing left in hole by depth, composition, and size.

(5) Copy of the boring log.

(6) Copy of construction diagram for abandoned well.

(7) Drilled and sampled depth prior to decision to abandon site.

(8) Items left in hole by depth, description, and composition.

(9) Description and total quantity of grout used initially.

(10) Description and daily quantities of grout used to compensate for settlement.

(11) Dates of grouting.

(12) Water or mud level (specify) prior to grouting and date measured.

(13) Remaining casing above ground surface: height above ground, size, and composition.

f. Ideally, replacement wells/borings (if any) will be offset at least 20 feet from any abandoned site in a presumed up- or cross-gradient groundwater direction. Site-specific conditions may necessitate variation to this placement.

12. Soil Samples.

a. Unless otherwise specified in the contract, intact soil samples for physical descriptions, retention, and potential physical analyses shall be taken and retained every five feet or at each major change of material, whichever occurs first. The contractor may propose an alternate sampling frequency in his technical plan. These samples shall be representative of their host environment and are to be obtained with driven (e.g., split spoon), pushed (e.g., thin wall), or rotary (e.g., Denison) type samplers. Auger flight or wash samples will not satisfy this requirement.

b. At the detection of any unusual odors off the auger turnings or intact samples, drilling shall cease for an evaluation of their nature and crew safety. After the field crew completes this evaluation and implements any appropriate safety precautions, drilling shall resume. If the odors are judged by the field crew to be contaminant-related, intact samples shall be continuously taken until the odors are no longer detected in the samples. At that time, normal sampling shall resume. Specific procedures shall be detailed in the contractor's proposal and Safety Plan.

c. Representative soil samples from each sampler shall be placed in half- or one-pint glass jars with air-tight, screw-type lids (canning jars). These jars shall be stored in individual compartments in cardboard boxes. A single box shall not contain more than 24 one-pint jars or 48 half-pint jars. For thin wall (shelby) samples, retain a sample from each tube as described above. The remaining portion may be wasted or sealed in the tube, as per testing requirements. Minimum information on each sample container shall include the boring and sample number. No geotechnical data shall appear on the container that is not specified on the boring log. Jars and tubes shall be kept from freezing.

d. Physical soil testing shall be conducted on ten (10) to twenty (20) percent of the soil samples using procedures and equipment described in the current U.S. Army Corps of Engineers Manual, EM 1110-2-1906: Laboratory Soils Testing, or current Annual Book of ASTM Standards, American Society of Testing and Materials, Part 19. Tested samples shall be representative of the range and frequency of soil types encountered. In addition, they shall be obtained from borings that cover the geographic and geologic range within the study area of the host Army installation. The contractor shall select the particular samples. Tests shall include Atterberg Limits, sieve grain size distribution, and assignment of Unified Soil Classification System symbols. Laboratory and summary sheets shall be submitted to the COR within ten working days of final test completion. The contractor shall address any contaminant-related safety precautions for the physical analysis of these samples in his proposal and Safety Plan.

e. Soil samples for chemical analysis taken from borings shall be obtained in a manner to provide intact specimens; using a split spoon or

solid barrel sampler, Denison sampler, etc. These samples shall be extracted from their host environment in as near an intact, undisturbed condition as technically practical. Once at the surface, the sampler shall be opened, sample extracted, peeled, and bottled in as short a time as possible. "Peeling" is a process whereby that portion of the sample which was in direct contact with the sampler, as well as the ends of the sample, are removed and discarded. Samples for volatile analysis shall be peeled, bottled, and capped within fifteen (15) seconds from the time of opening the sampler. Additional acquisition, preservation, and handling criteria for the chemical analysis of soils are found in the current Quality Assurance Program.

f. All soil samples, except those for physical and/or chemical analysis and reference shall remain onsite, neatly stored at a USATHAMA-designated location. The disposition of these samples will be arranged between USATHAMA and the host installation.

13. Rock Core. The preferred method of drilling bedrock is through coring. This method, using a diamond or carbide studded bit, produces a generally intact sample of the bedrock lithology, structure, and physical condition. The use of a gear-bit, tricone, etc., to penetrate bedrock should only be considered for the confirmation of the "top of rock" (where penetration is limited to a few feet), the enlargement of a previously cored hole, or the drilling of highly fractured intervals.

a. The coring of bedrock or any firm stratigraphic unit shall be conducted in a manner to obtain at least 90% intact recovery. The physical character of the bedrock; i.e., fractures, poor cementation, weathering, or solution cavities, may lessen the desired recovery, even with the best of drillers and equipment.

b. While drilling in bedrock, and especially while coring, drilling fluid pressures shall be adjusted to minimize drilling fluid losses and hydraulic fracturing.

c. Rock cores shall be stored in covered wooden boxes in such a manner as to preserve their relative position by depth. Intervals of lost core shall be noted in the core sequence with annotated wooden blocks. Boxes shall be marked inside and out to provide boring number, cored interval, and box number in cases of multiple boxes. The weight of each fully loaded box shall not exceed 75 pounds. No geotechnical data shall appear on or within the box that is not specified on the boring log. As a minimum, the estimated number of boxes required for each boring shall be on hand prior to coring that site.

d. The core within each completed box shall be photographed after the core surface has been cleaned/peeled and wetted. Photos shall be taken using color film (ASA as appropriate), 35mm camera, 55mm (minimum) lens, light meter, with one box per frame. Each photo shall be in sharp focus and contain both a legible scale in feet and tenths of feet (or centimeters) and a USATHAMA-supplied photographic color chart for color comparison. The core shall be oriented so that the top of the core is at the top of the photo. One set of 3 x 5 inch glossy color prints plus all negatives shall be sent to USATHAMA via registered mail within 2 weeks of the last coring. Each photo shall be annotated on the back as to the bore/well designation, box number, and cored

depths denoted in the photograph. The photos shall be used to enhance the interpretation of core sketches and corresponding narrative descriptions.

e. All rock core, except that for analysis and reference, shall remain onsite, neatly stored at a USATHAMA-designated location. The disposition of these samples will be arranged between USATHAMA and the host installation.

14. Drilling in Contaminated Areas. Many borings and wells are drilled in areas that are clean relative to the deeper horizons of interest. However, circumstances do arise which require drilling where the overlying soils or shallow aquifer may be contaminated relative to the underlying environment. This situation requires the placement of, at least, double casing: an outer permanent (or temporary) casing sealed in place and cleaned of all previous drill fluids prior to proceeding into the deeper, "cleaner" environment. These situations shall be addressed by the contractor on a case-by-case basis in the technical plan.

15. Equipment Cleaning. The steam cleaning of all drilling equipment to include rigs, water tanks (inside and out), augers, drill casings, rods, samplers, tools, recirculation tanks, etc., shall be done prior to project site (installation) arrival followed by onsite steam cleaning with approved water (III.A.10.b.) upon site arrival and between boring/well sites. Prior to use onsite, all casings, augers, recirculation and water tanks, etc., shall be devoid both inside and out of any asphaltic, bituminous, or other encrusting or coating materials, grease, grout, soil, etc. Paint, applied by the equipment manufacturer, need not be removed from drilling equipment. To the extent practical, all cleaning shall be performed in an area that is remote from and surficially cross- or downgradient from any site to be sampled.

16. Work Area Restoration, Disposal of Borehole Cuttings and Well Water. All work areas around the wells and/or borings installed as part of this contract shall be restored to a physical condition equivalent to that of preinstallation. This includes cuttings removal or spreading and rut removal. Borehole cuttings, drilling fluids, and water removed from a well during installation, development, aquifer testing, and presample purging shall be disposed of in a manner approved by the Contracting Officer and the host installation. The contractor shall suggest a disposal procedure and location(s) as part of his technical plan.

17. Physical Security.

a. On Post: While physical security measures are present on most Army properties, the contractor has the ultimate responsibility for securing his own equipment. The contractor shall address any special needs to the onsite installation personnel and include these items in his technical plan.

b. Off Post: For any operations off post, the contractor is totally responsible for his own physical security.

B. Borehole Logging. Each boring log shall fully describe the subsurface environment and the procedures used to gain that description.

1. Format. The format of the boring log shall be determined by the contractor. A suggested format is presented in Figure 4.

III.B.

2. Submittal. Each original boring log shall be submitted directly from the field to the Contracting Officer's designated office within three working days after the boring is completed. In those cases where a monitor well or other instrument is to be inserted into the boring, both the log for that boring and the installation diagram must be submitted within three working days after the instrument is installed.

3. Originals. Only the original boring log (and diagram) shall be submitted from the field to fulfill the above requirement. Carbon, typed, or reproduced copies shall not suffice.

4. Time of Recording. Logs shall be recorded directly in the field without transcribing from a field book or other document. This technique reduces offsite work hours for the geologist, lessens the chance for errors of manual copying, and allows the completed document to be field-reviewed closer to the time of drilling.

5. Routine Entries. In addition to the data desired by the contractor and uniquely required by contract, the following information shall be routinely entered on the boring log or attached to the log:

a. Depths/heights shall be recorded in feet and fractions thereof (tenths or inches). Metric measurements are acceptable if typically used by the geologist. The DMS does not accept entries in inches.

b. Soil classifications shall be in accordance with the Unified Soil Classification System (equivalent to ASTM D 2487-69).

c. Soil classifications shall be prepared in the field at the time of sampling by the geologist and are subject to change based upon laboratory tests and/or subsequent review. The mere difference between laboratory and field classification is not sufficient to change the field classification. Additional factors to consider before changing a field determination include the expertise of the field geologist and laboratory personnel, representative character of the tested sample, labeling errors, etc. Any changes made after this consideration shall be discussed and incorporated in the project report(s). The contractor shall also initiate any subsequent corrections to the Data Management System.

d. Each soil sample taken (see III.A.12.) shall be fully described on the log. The descriptions of intact samples shall include the following parameters:

PARAMETER	EXAMPLE
Classification	Sandy Clay
Unified Soil Classification Symbol	CL
Secondary Components and Estimated Percentages	Sand: 25% (Fine sand 5%, Coarse sand 20%)
Color (using Munsell Soil or Geological	Gray: 7.5 YR 5.0 (Munsell)

Society of America (GSA) Rock Color Chart), give both narrative and numerical description and note which chart used.	
Plasticity	Low Plasticity
Consistency (cohesive soil)	Stiff
Density (non-cohesive soil)	Loose
Moisture Content. Use relative term. Do not express as a percentage unless a value has been measured.	Dry, moist, wet, etc.
Texture/Fabric/Bedding and Orientation	No apparent bedding: numerous vertical, iron-stained, tight fractures
Grain Angularity	Rounded
Depositional Environment and Formation, if named	Glacial till, Twin Cities Formation

e. In the field, visual numeric estimates shall be made of secondary soil constituents; e.g., "silty sand with 20 percent fines" or "sandy gravel with 40 percent sand." If such terms as "trace," "some," "several," etc., are used, their quantitative meaning is to be defined on each log or within a general legend.

f. When used to supplement other sampling techniques, disturbed samples; e.g., wash samples, cuttings, and auger flight samples, shall be described in terms of the appropriate soil/rock parameters to the extent practical. "Classification" shall be minimally described for these samples, along with a description of drill action and water losses/gains for the corresponding depth.

g. Rock core shall be visually described for the following parameters:

PARAMETER	EXAMPLE
Classification	Limestone, Sandstone, Granite
Lithologic Characteristics	Shaly, Calcareous, Siliceous, Micaceous
Bedding/Banding Characteristics	Laminated, Thin bedded, Massive, Cross bedded, Foliated
Color (using Munsell Soil or GSA Rock Color Chart), give both narrative and numerical description and note which chart was used.	Mod. brown: 5 YR 3/4 GSA

Hardness	Soft, Very hard
Degree of Cementation	Poorly cemented, Well cemented
Texture	Dense, Fine-, Medium-, Coarse-grained, Glassy, Porphyritic, Crystalline
Structure and Orientation	Horizontal bedding, Dipping beds at 30°, Highly fractured, Open vertical joints, Healed 30° faults/fractures, Slickensides at 45°, Fissile
Degree of Weathering	Unweathered, Badly weathered
Solution or Void Conditions	Solid, Cavernous, Vuggy with partial infilling by clay
Primary and Secondary Permeability, include estimates and rationale	Low primary: Well cemented High secondary: Several open joints
Lost Core, interval and reason for loss	50-51', noncemented sandstone likely

h. For rock core, provide a scaled graphic sketch of the core on or with the log denoting by depth the location, orientation, and nature (natural or coring-induced) of all core breaks. Note also the intervals by depth of all lost core and hydrologically significant details. This sketch shall be prepared at the time of core logging, concurrent with drilling.

i. Record the brand name and amount of any bentonite used for each boring along with the reason for and start (by depth) of this use.

j. The drilling equipment used shall be generally described either on each log or in a general legend. Record such information as rod size, bit type, pump type, rig manufacturer and model.

k. Each log shall record the drilling sequence; e.g.:

(1) Opened hole with 8" auger to 9'.

(2) Set 8" casing to 10'.

(3) Cleaned out and advanced hole with 8" roller bit to 15' (clean water, no water loss).

(4) Drove standard sampler to 16.5'.

(5) Advanced with 8" roller bit to 30', 15 gallon water loss.

(6) Drove standard sampler to 31.5'.

(7) Hole heaved to 20'.

(8) Mixed 25 pounds of ABC bentonite in 100 gallons of water for hole stabilization and advanced with 8" roller bit to 45', etc.

l. Record all special problems and their resolution on the log; e.g., hole squeezing, recurring problems at a particular depth, sudden tool drops, excessive grout takes, drilling fluid losses, unrecovered tools in hole, lost casings, etc.

m. The dates for the start and completion of borings shall be recorded on the log along with notation by depth for drill crew shifts and individual days.

n. Each sequential boundary between the various soils and individual lithologies shall be noted on the log by depth. When depths are estimated, the estimated range shall be noted along the boundary.

o. The depth of first encountered free water shall be indicated along with the method of determination; e.g., "37.6' from direct measurement after drilling to 40.0';" or "40.1' from direct measurement in 60' hole when boring left overnight, hole dry at end of previous shift;" or "25.0' based on saturated soil sample while sampling 24-26'." Allow the first encountered water to partially stabilize (5 to 10 minutes) and record this secondary level and time between measurements before proceeding. Also describe any other distinct water level(s) found below the first.

p. The estimated interval by depth for each sample taken, classified, and/or retained shall be noted on the log. For each driven (split spoon), thin wall (shelby), and cored sample, record the length of sampled interval and length of sample recovery. Record the sampler type and size (diameter and length).

q. Record the blow counts, hammer weight, and length of hammer fall for driven samplers. For thin wall samplers, indicate whether the sampler was pushed or driven. Blow counts shall be recorded in half foot increments when standard (1 3/8" ID by 2" OD) samplers are used. For penetration less than a half foot, annotate the count with the distance over which the count was taken.

r. When drilling fluid is used, quantitatively record fluid losses and/or gains and the interval over which they occur. Adjust fluid losses for spillage and intentional wasting (e.g., recirculation tank cleaning) to more accurately estimate the amount of fluid lost to the subsurface environment.

s. Record the pumping pressures typically used during all rotary drilling operations.

t. Note the total depth of drilling or sampling, whichever is deeper, on the log.

u. Record significant color changes in the drilling fluid return, even when intact soil samples or rock core are being obtained. Include the color change (from and to), depth at which change occurred, and a lithologic description of the cuttings before and after the change.

v. Special abbreviations used on a log and/or well diagram shall be defined either in the log/diagram where used, or in a general legend. The general legend, if used, shall be forwarded to USATHAMA with the first log/diagram submittal. An addendum, if required, shall be sent to USATHAMA with the last log/diagram.

C. Well Installation. In the Geotechnical Requirements, the term "monitor well" is used in a generic sense to include observation wells and piezometers. Observation wells differ from piezometers in the length of the open or screened section of the well and location of the well seal (usually bentonite) in relation to the potentiometric or phreatic surface of the aquifer being measured (see Figure 10). Each monitor well is intended for use as a mechanism through which to obtain a representative sample of groundwater and measure the potentiometric surface seen by that well. The installation of either well type is covered by these Requirements. These Requirements are also applicable to other types of hydrogeologic instrumentation; e.g., lysimeters and well points (see Figure 10). The criteria for these and other special instrumentation will be discussed in the specific RFP/RFQ, contract, task, and/or amendment. Any questions regarding these items should be addressed to the COR.

1. Beginning Well Installation.

a. The installation of each monitor well shall begin within 12 consecutive hours of boring completion for holes uncased or partially cased with temporary drill casing. Installation shall begin within 48 consecutive hours in holes fully cased with temporary drill casing. Once installation has begun, no breaks in the installation process shall be made until the well has been grouted and drill casing removed. Anticipated exceptions shall be requested in writing by the contractor to the Contracting Officer through USATHAMA for consideration prior to drilling. Allow three working days from the time of receipt by USATHAMA for request evaluation and recommendation. Data to include in this request are:

(1) Well(s) in question.

(2) Circumstances.

(3) Recommendation and alternatives.

b. In cases of unscheduled delays such as personal injury, equipment breakdowns, sudden inclement weather; or scheduled delays such as borehole geophysics, no advance approval of delayed well installation is needed. In those cases, resume installation as soon as practical. In cases where a partially cased hole into bedrock is to be partially developed prior to well insertion (III.D.11.), the well installation shall begin within 12 consecutive hours after this initial development.

c. Once begun, well installation shall not be interrupted due to the end of the contractor's/driller's work shift, darkness, weekend, or holiday.

d. The contractor shall ensure that all materials and equipment for drilling and installing a given well are available and onsite prior to drilling that well. The contractor shall have all equipment and materials onsite prior to drilling and installing any well if the total well drilling and installation effort is scheduled to take 14 consecutive days or less. ("Consecutive days" refers to the continuous combination of "working" and "nonworking days;" i.e., "calendar days."). For longer schedules, the contractor shall ensure that the above materials needed for at least 14 consecutive days of operation are onsite prior to well drilling. The balance of materials shall be either on order or in transit prior to well drilling.

2. Screens, Casings, and Fittings.

a. Typically, only polyvinyl chloride (PVC), polytetrafluoroethylene (PTFE), and/or stainless steel shall be used. All PVC screens, casings, and fittings shall conform to National Sanitation Foundation (NSF) Standard 14 for potable water usage (or American Society for Testing and Materials (ASTM) equivalent) and bear the appropriate rating logo. If a contractor uses a screen and/or casing manufacturer or supplier who removes or does not apply this logo, the contractor shall include in the Technical Plan a written statement from the manufacturer/supplier (and endorsed by the contractor) that the screens and/or casing have been appropriately rated by NSF/ASTM. Specific materials will be specified in the RFP/RFQ or proposed by the contractor in his RFP/RFQ response for the Contracting Officer's approval. All materials shall be as chemically inert with respect to the site environment as technically possible and practical.

b. All well screens shall be commercially fabricated, slotted or continuously wound, and have an inside diameter equal to or greater than the well casing. For PVC and PTFE screens, their schedule/thickness shall be the same as that of the well casing. Stainless steel screens may be used with PVC or PTFE well casing. No fitting shall restrict the inside diameter of the joined casing and/or screen. All screens, casings, and fittings shall be new.

c. All well screens and well casings shall be free of foreign matter (e.g., adhesive tape, labels, soil, grease, etc.) and washed with approved water prior to use. Pipe nomenclature stamped or stenciled directly on the well screen and/or blank casing within and below the bentonite seal shall be removed (via SANDING). Solvents shall NOT be used for marking removal. Washed screens and casings shall be stored in plastic sheeting or kept on racks prior to insertion.

d. Well screens shall be placed no more than three feet above the bottom of the drilled borehole.

e. All screen bottoms shall be securely fitted with a threaded cap or plug of the same composition as the screen. This cap/plug shall be within 0.5' of the open portion of the screen (see Figures 5 and 6). No solvents or glues shall be permitted for attachment.

f. Silt traps (also called "cellars") shall not be used. A silt trap is a blank length of casing attached to and below the screen. Their use fosters a stagnant environment which could influence analytical results for trace concentrations.

g. Joints within and between the casing and screen shall be compatibly threaded. Thermally welded joints or couplings shall not be used. This prohibition includes threaded or slip joint couplings thermally welded to casing by the manufacturer or in the field. Solvent welded joints may be used only to make casing repairs or to adjust casing height. Any glue or solvent usage shall be described on the log or well diagram. During these repairs or adjustments which require solvent/glue usage, a clean rag should be tightly fit into the intact well casing to catch any glue spillage. This rag shall be attached to a strong twine for ease of rag removal and to preclude rag loss down the well. The rag and twine shall be removed upon repair completion.

h. Gaskets shall not be used on monitor wells.

i. The top of each well installed under these Requirements shall be level such that the difference in elevation between the highest and lowest part of the well casing/riser shall be less than or equal to 0.02'.

3. Caps and Vents. The tops of all well casings shall be telescopically capped with loosely fitting PVC, PTFE, or stainless steel covers. These covers shall be constructed to preclude binding to the well casing due to tightness of fit, unclean surface, or frost and secure enough to preclude debris and insects from entering the well. No vents shall be placed in these caps (or well risers/stickup). Therefore, the caps shall be loose enough to allow pressure equalization between the well and atmosphere.

4. Centralizers. Well centralizers, when used, shall be of PVC, PTFE, or stainless steel and attached to the casing via stainless steel fasteners or strapping. Centralizers shall not be attached to the well screen or to that part of the well casing exposed to the granular filter or bentonite seal.

5. Granular Filter Pack.

a. All granular filters must be approved by the Contracting Officer prior to drilling. A one-pint representative sample of each proposed granular filter pack, accompanied by the data below, III.C.5.a.(1)-(6), shall be submitted by the contractor to the Contracting Officer through USATHAMA for consideration prior to drilling. Allow eight working hours for evaluation and recommendation once all of the above data are received by USATHAMA. Each sample shall be described, in writing (see Figure 3), in terms of:

(1) Lithology.

(2) Grain size distribution.

(3) Brand name, if any.

(4) Source, both manufacturing company and location of pit or quarry of origin.

(5) Processing method; e.g., pit run, screened and unwashed, screened and washed with water from well/river/pond, etc.

(6) Slot size of intended screen.

b. Granular filter packs shall be chemically and texturally clean (as seen through a 10X hand lens), inert, siliceous, and of appropriate size for the well screen and host environment.

c. The filter pack shall extend above the top of the screen by at least five feet, unless otherwise specified in the statement of work.

d. The final depth to the top of the granular filter shall be directly measured (via tape or rod) and recorded. Final depths are not to be estimated; as, for example, based on volumetric measurements of placed filter.

6. Bentonite Seals.

a. Bentonite seals shall be composed of commercially available pellets. Pellet seals shall be a minimum of five feet thick as measured immediately after placement, without allowance for swelling.

b. Slurry seals shall be used only as a last resort, as when the seal location is too far below water to allow for pellet or containerized-bentonite placement or within a narrow well-borehole annulus. Slurry seals shall have a thick, batter-like (high viscosity) consistency with a placement thickness of five feet maximum.

c. In wells designed to monitor bedrock, the top of the bentonite seal shall be located at least three feet below the top of firm bedrock, as may be determined by drilling. "Firm bedrock" refers to that portion of solid or relatively solid, moderately to unweathered bedrock where the frequency of loose and fractured rock is markedly less than in the overlying, highly weathered bedrock. The interval between the top of the bentonite seal and the top of the highly weathered bedrock shall be filled with grout. Figure 6 denotes the seal location.

d. The final depth to the top of the bentonite seal shall be directly measured (via tape or rod) and recorded. Final depths are not to be estimated; as, for example, based on volumetric measurements of placed bentonite.

7. Grouting. Grout mix design and placement are detailed in paragraph III.A.10.c.

8. Well Protection.

a. Protective casing shall be installed around each monitor well the same day as initial grout placement around that well. Any annulus formed between the outside of the protective casing and borehole shall be filled to ground surface with grout as part of the grouting procedure. Requests for exceptions in usage, design, and timing of placement will be considered on a case-by-case basis by the Contracting Officer. Request in writing shall be made prior to drilling. Include in the request the well(s) involved, reason for

request, cost savings, recommendation, and alternatives. Allow six working days for evaluation and recommendation after the request is received by USATHAMA.

b. All protective casing shall be steam cleaned prior to placement, free of extraneous openings, devoid of any asphaltic, bituminous, encrusting, and/or coating materials (except the black paint or primer applied by the manufacturer).

c. Minimum elements of protection design include:

(1) A 5-foot minimum length of new, black iron/steel pipe extending about 2.5 feet above ground surface and set in grout (see Figures 5, 6 and 7).

(2) An 8" protector pipe for 5" wells.

(3) A 6" protector pipe for 4" wells.

(4) A 5" protector pipe for 3" wells.

(5) A 4" protector pipe for 2" wells.

(6) A hinged cover or loose fitting telescoping cap to keep direct precipitation and cover runoff out of the casing.

(7) All protective casing covers/caps secured to the casing by means of a padlock from the date of protective casing installation.

(8) All padlocks at a given site (Army installation) opened by the same key. The contractor shall provide two of these keys to a Contracting Officer's designated representative at the installation and two keys to USATHAMA upon the conclusion of well placement.

(9) No more than .2' from the top of protective casing to the top of well casing. This, or a smaller spacing, is critical for subsequent water level determination via acoustical equipment.

(10) The outside only of the protective casing, hinges (if present), and covers/caps painted orange with a paint brush (not aerosol can). Painting required to be completed and dry prior to initially sampling that well. Any color deviations will be conveyed to the contractor by the COR.

(11) The painting of the well designation on the outside of the protective casing, using white paint and a brush. The identification shall be done after the casing is painted as described above. Painting required to be completed and dry prior to initially sampling that well.

(12) The erection of four steel pickets, each radially located 4 feet from each well, placed 2 to 3 feet below ground surface, having 3 feet minimally above ground surface with flagging in areas of high vegetation (see Figure 7). The pickets shall be painted orange, using a brush. Installation and painting shall be completed (and dry) prior to sampling the well.

(13) The above pickets (III.C.8.c.(12)) shall be supplemented with three-strand barbed wire in livestock grazing areas. Installation required prior to sampling.

(14) The placement of an internal mortar collar within the well-protective casing annulus from ground surface to 1/2 foot above ground surface with a 1/4" diameter hole (drainage port) in the protective casing centered 1/8" above this level (see Figures 5 and 6). The mortar mix shall be (by weight) 1 part cement to 2 parts sand (the granular filter used around the well screen), with minimal water for placement. Placement required at least 48 consecutive hours prior to well development.

(15) The application of an approximately .5' thick coarse gravel (3/4" to 3" particle size) blanket extending 4' radially from the protective casing (see Figure 8 for layout and dimensions). Application required prior to development.

(16) Unique specifications for flood protection, if applicable, will be covered on a case-by-case basis.

9. Drilling Fluid Removal. When a borehole, made with or without the use of drilling fluid, contains an excessively thick, particulate-laden fluid which would preclude or practically hinder contractual well installation, the borehole fluid should be removed or displaced with approved water (section III.A.10.b.). This removal is intended to remove or dilute the thick fluid and thus allow the proper placement of casing, screen, granular filter, and seal. Fluid losses in this operation shall be initially recorded on the well diagram or boring log and later on the well development record (also see III.D.6., 11., and 14.). Any fluid removal prior to well placement is contingent upon the driller's and the geologist's evaluation of hole stability long enough for the desired well and seal placement.

10. Drilling Fluid Losses in Bedrock. For an option to remove drilling water from bedrock prior to well insertion, see paragraph III.D.11.

11. Schematic Well Construction. Figures 5 and 6 depict schematic well construction. Specific contract requirements described in the statement of work may alter some of the components and/or values shown.

12. Well Construction Diagrams.

a. Each installed well shall be depicted in a well diagram. This diagram shall be attached to the bore log for that installation and shall graphically denote, by depth from ground surface (unless otherwise specified):

(1) The bottom of the boring (that part of the boring most deeply penetrated by drilling and/or sampling) and boring diameter(s).

(2) Screen location.

(3) Joint locations.

(4) Granular filter pack.

(5) Seal.

(6) Grout.

(7) Cave-in.

(8) Centralizers.

(9) Height of riser without cap/plug above ground surface (stickup).

(10) Protective casing detail.

(a) Height of protective casing without cap/cover (above ground surface).

(b) Base of protective casing.

(c) Drainage port location and size.

(d) Internal mortar collar location.

(e) Gravel blanket height and extent.

(f) Picket configuration.

b. Describe on the diagram or on an attachment thereto:

(1) The actual quantity and composition of the grout, seals, and granular filter pack used for each well.

(2) The screen slot size (in inches), slot configuration, total open area per foot of screen, outside diameter, nominal inside diameter, schedule/thickness, composition, and manufacturer.

(3) The outside diameter, nominal inside diameter, schedule/thickness, composition, and manufacturer of the well casing.

(4) The joint design and composition.

(5) Centralizer design and composition.

(6) Protective casing composition and nominal inside diameter.

(7) The use of solvents, glues, and cleaners to include manufacturer and type (specification).

(8) Special problems and their resolutions; e.g., grout in wells, lost casing and/or screens, bridging, etc.

(9) Dates for the start and completion of well installation.

c. Each diagram shall be attached to the boring log and submitted from the field to the Contracting Officer's designated office within three

working days after well installation. Do not delay this submission until all elements of well protection have been installed. Submit a supplemental diagram for well protection elements to the same designated office within three working days after all elements of well protection are installed.

d. Only the original well diagram and log shall be submitted to fulfill the above requirement. Carbon, typed, or reproduced copies shall not suffice. A legible copy of the well diagram may be used as a base for the supplemental protection diagram.

e. For abbreviations in the diagrams, see section III.B.5.v.

D. Well Development and Presample Purging.

1. Development: Definition and Purpose. As used herein, "well development" is that process by which one restores the aquifer's hydraulic conductivity and removes well drilling fluids, solids, and other mobile particulates from within and adjacent the newly installed well. "Development" can also refer to that process whereby one removes sediment or other built-up materials from a "clogged," older well. The resulting inflow should be as physically and chemically representative of the host aquifer as the following procedures allow for a newly installed well.

2. Timing and Record Submittal. The development of monitor wells shall be initiated not sooner than 48 consecutive hours after nor longer than 7 calendar days beyond internal mortar collar placement. The record of well development (see section III.D.14.) shall be submitted to the COR within three working days after development.

3. Pump and Bailer Usage. Development shall be accomplished with a pump and may be supplemented with a bottom discharge/filling bailer (for sediment removal) and surge block. A bottom discharge/filling bailer may be used in lieu of a pump in 2-inch wells. Bailers shall not be left inside the wells after development is completed.

4. Development Criteria. Development shall proceed in the manner described herein and continue until all the following are met:

a. The well water is clear to the unaided eye.

b. The sediment thickness remaining within the well is less than 1% of the screen length.

c. The conditions of paragraph III.D.5. (below) are met.

5. Volumetric Removal. In addition to minimally removing five times the standing water volume in the well (to include the well screen and casing plus saturated annulus, assuming 30% porosity), the following apply:

a. For those wells where the boring was made by the use of cable tool, auger, or air rotary methods and without the use of drilling fluid (mud and/or water), only the five volumes plus five times any water used in granular filter pack placement need be minimally removed. Should recharge be so slow that the required volume cannot be removed in 48 consecutive hours, the water

remains discolored, or excess sediment remains after the five volume removal; contact the Contracting Officer's designated office for guidance.

b. For those wells where the boring was made or enlarged (totally or partially) with the use of drilling fluid (mud and/or water), remove five times the measured amount of total fluids lost while drilling plus five times the combined amount of standing water,annular water, and that used in filter pack placement as above. The same procedures apply here as above with respect to slow recharge, discoloration, and sediment thickness.

c. See sections III.C.9., III.D.6., and III.D.11. for optional procedures and the requirements if these options are used.

6. Water Additions and Wells with Thick Fluids. Water shall not be added to a well as part of development once the initial seal is placed. However, when a bore, made with or without the use of drilling fluid, contains an excessively thick, particulate-laden fluid which would preclude or practically hinder contractual well installation, the contractor should purge or dilute this fluid with clean water from the approved source (also see III.C.9.). A record of purging fluid losses shall be made on both the log or diagram and well development record (III.D.14.). Five times the volume of this loss shall be added to the other volumetric removal requirements for well development.

7. Agents and Additives. No dispersing agents, acids, disinfectants, or other additives shall be used during development or at any other time introduced to the well.

8. Development-Sampling Break. Well development shall be completed at least fourteen consecutive days before well sampling.

9. Pump/Bailer Movement. During development, water shall be removed throughout the entire water column by periodically lowering and raising the pump intake (or bailer stopping point).

10. Development Water Sample. For each well, a one-pint sample of the last water to be removed during development shall be obtained and given to the installation environmental coordinator (or USATHAMA-specified individual) for disposition, within three working days of developing that well. No preservation of these samples is required. However, the contractor shall ensure that these samples do not freeze while in his possession.

11. Partial Bedrock Development. If large drilling water losses occur in bedrock and if the hole is cased to bedrock, the contractor may remove at least five times this volumetric loss prior to well insertion. The intent here is to allow the placement of a larger pump in the borehole than otherwise possible in the well casing thereby reducing the development time and removing the lost water closer to the time of loss. Development of the completed well could then be reduced by a volume equal to that which was removed as above. However, the requirement shall still remain to remove at the time of well development at least five times the combination of standing water, water in the saturated annulus, plus that which was added during filter pack placement. Record the amount removed per above on the well diagram and in the well development record (III.D.14.).

12. Well Washing. Part of well development shall be the washing of the entire well cap and the interior of the well casing above the water table using only water from that well. The result of this operation shall be a well casing free of extraneous materials (grout, bentonite, sand, etc.) inside the riser, well cap, and blank casing between the top of the well casing and the water table. This washing shall be conducted before and/or during development, not after development.

13. Problems. If problems are encountered during development, contact the COR within 24 consecutive hours for guidance.

14. Well Development Record Requirements. The following data shall be recorded as part of development and submitted per section III.D.2.:

a. Well designation.

b. Date(s) of well installation.

c. Date(s) of well development.

d. Static water level from top of well casing before and 24 consecutive hours after development.

e. Quantity of mud/water:

(1) Lost during drilling.

(2) Removed prior to well insertion (III.D.11.).

(3) Lost during thick fluid displacement (III.C.9. and III.D.6.).

(4) Added during granular filter placement.

f. Quantity of fluid in well prior to development.

(1) Standing in well.

(2) Contained in saturated annulus (assume 30% porosity).

g. Field measurement of pH before, twice during, and after development using an electrometric device (EPA 150.1-Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020).

h. Field measurement of specific conductance (electrical conductivity) before, twice during, and after development using a conductivity meter (EPA 120.1-Methods for Chemical Analysis of Water and Wastes, EPA 600/4 - 79-020). Obtain conductance and pH readings concurrently.

i. Depth from top of well casing to bottom of well (from diagram).

j. Screen length (from diagram).

k. Depth from top of well casing to top of sediment inside well, before and after development.

l. Physical character of removed water, to include changes during development in clarity, color, particulates, and odor.

m. Type and size/capacity of pump and/or bailer used.

n. Description of surge technique, if used.

o. Height of well casing above ground surface.

p. Typical pumping rate.

q. Estimated recharge rate.

r. Quantity of fluid/water removed and time for removal (present both incremental and total values).

15. Presample Purging: Definition and Purpose. "Presample purging" refers to the removal of water from a well IMMEDIATELY prior to sample acquisition. This ensures a fresh and representative sample for analysis. In general, the USATHAMA Installation Restoration Program, Quality Assurance Program requires five times the calculated volume of water in the well and saturated well annulus to be removed immediately prior to sampling. Therefore, any water removed from a well as part of "development" shall not be counted toward the volumetric removal required in presample purging. Additional presample purging requirements are discussed in the current USATHAMA Quality Assurance Program.

E. Water Levels.

1. Measurement and Datum. The depth to groundwater shall be measured from the highest point on the rim of the well casing or riser (not protective casing). This same point on the well casing shall be surveyed for vertical control (see III.I.2). The depths to groundwater shall be converted to elevations for report usage. To enter the depths into the Data Management System, the well riser height above ground surface (stickup) must be subtracted from the above measured depth.

2. Contour Requirements. For contouring and reporting purposes, at least one complete set of static water level measurements shall be made over a single, consecutive 10-hour period for all wells (newly installed and specified) in the project. Static levels in borings not converted to wells shall be included if practical and technically appropriate.

3. Ground and Surface Water. Determine and report the elevations, to within ± 0.1 foot, of any streams, lakes, or open water bodies (natural and man-made), within 300 feet of monitor wells used in this contract or task. Use these data for the refinement of the groundwater contours in the vicinity of surface water if a hydrological connection is believed to exist.

F. Well and Boring Acceptance Criteria.

III.F.

1. Well Criteria. Wells must be acceptable to the Contracting Officer. Well acceptance shall be on a case-by-case basis. The following criteria shall be used along with individual circumstances in the evaluation process.

a. The well and material placement shall meet the construction and placement specifications of these <u>Geotechnical Requirements</u> as modified, if at all, by the contract/task.

b. Wells/boreholes shall not contain portions of drill casing or augers unless they are contractually required as permanent casing.

c. All well casing and screen materials shall be free of any unsecured couplings, ruptures or other physical breakage/defects before and after installation.

d. The annular material (filter pack, bentonite, and grout) surrounding each installed well shall form a continuous and uniform structure, free of any fractures or cracks.

e. Any casing or screen deformation or bending shall be minimal to the point of allowing the insertion and retrieval of the pump and/or bailer optimally designed for that size casing (e.g., a 4-inch pump in a 4-inch schedule 40, PVC casing is optimal; a 2-inch pump in a 4-inch casing is not optimal).

f. All joints shall be constructed to provide a straight, nonconstricting, and water-tight fit.

g. Installed wells (fully or partially cased) shall be free of extraneous objects or materials (e.g., tools, pumps, bailers, packers, excessive sediment thickness, grout, etc.).

h. For those monitor wells where the screen depth was determined by the contractor, the well shall have sufficient free water at the time of water level measurement (III.E.2.) to obtain a representative groundwater level for that site. These same wells shall have sufficient free water, at the time of initial sampling, which is representative of the desired portion of the aquifer for the intended chemical analysis.

i. Data for all required geotechnical files in the Data Management System shall be acceptably entered and verified by the contractor.

2. Abandoned Borings and Wells. Borings not completed as wells shall be abandoned per section III.A.11. and the data therefrom acceptably entered and verified by the contractor into the Data Management System.

3. Well and Boring Rejection. Wells and borings not meeting these criteria are subject to rejection by the Contracting Officer.

G. Geophysics. The use of geophysical techniques, if required, will be specified in the RFP/RFQ. In the absence of this specification, the contractor should consider these techniques for site-specific applicability to enhance the technical acuity and cost-effectiveness of his efforts. Special applications

may be useful in unexploded ordnance detection, disturbed area delineation, contaminant detection, depth to bedrock, buried drum detection, borehole and well logging, etc. When proposed for Contracting Officer approval, the contractor shall include the purpose, particular method(s) and equipment, selection rationale, methods and procedural assumptions, limitations (theoretical and site-specific), resolution, and accuracy. The contractor shall also address the safety aspects of geophysical applications in his proposal and Safety Plan, especially for those areas where induced electrical currents or seismic waves could detonate unexploded ordnance or other explosive materials. If geophysical techniques are used, the same topics shall be addressed in the geotechnical report.

H. Vadose Zone Monitoring. Data acquisition from the vadose (unsaturated) zone shall be addressed on a case-by-case basis. The use of lysimeters in a silica flour matrix, soil-gas monitors, and analysis of bulk soil samples are mechanisms which may be employed by the contractor. When proposed for Contracting Officer approval, the contractor shall include the purpose, particular method(s) and equipment, selection rationale, methods and procedural assumptions, limitations (theoretical and site-specific), and analytical variances from the current USATHAMA Quality Assurance Program.

I. Topographic Survey.

1. Horizontal Control. Each boring and/or well installed under this contract shall be topographically surveyed by a licensed surveyor to determine its map coordinates using a Universal Transverse Mercator (UTM) or State Planar grid to within $\pm$ 3' ($\pm$ 1 meter).

2. Vertical Control. Elevations for the natural ground surface (not the top of the coarse gravel blanket) and the highest point on the rim of the uncapped well casing (not protective casing) for each bore/well site shall be surveyed by a licensed surveyor to within $\pm$ 0.05' ($\pm$ 1.5 centimeters) using the National Geodetic Vertical Datum of 1929.

3. Field Data. The topographic survey shall be completed as near to the time of last well completion as possible, but no longer than five weeks after well installation. Survey field data (as corrected), to include loop closure for survey accuracy, shall be included within the geotechnical or final report. Closure shall be within the horizontal and vertical limits given above. These data shall clearly list the coordinates (and system) and elevation (ground surface, top of well, and protective casings) as appropriate, for all borings, wells, and reference marks. All permanent and semipermanent reference marks used for horizontal and vertical control (bench marks, caps, plates, chiseled cuts, rail spikes, etc.) shall be described in terms of their name, character, and physical location.

J. Data Management System.

1. Usage of the Data Management System (DMS) is a means to record and monitor contract performance; store, compare, and evaluate data; and provide cost-efficient, report quality tables and graphics. The System is thereby useful to both administrative and technical users.

2. The geotechnical data acceptably entered in the computer shall be regarded as having the technically best quality for evaluation and decision making. Any deviation from the field data shall be specified and discussed by the contractor in the geotechnical report (see III.B.5.c. and III.K.3.j.(6)).

3. To computerize all of the field-generated data would be neither useful nor cost-effective for most projects. Therefore, only those items specified in III.J.6. shall be acceptably entered on a routine basis by the contractor for each contract or task. These data shall be entered for new borings, wells, and other sampling points; e.g., existing wells, surface water, sediment, and soils, specified in the contract or task. If the contractor wishes to use additional geotechnical files or entries, the contractor shall first receive COR's approval.

4. The items selected for DMS entry shall be entered in one or more of four geotechnical files:

a. Map File (GMA).

b. Field Drilling File (GFD).

c. Well Construction File (GWC).

d. Groundwater Stabilized File (GGS).

5. These files, and others, along with data entry procedures are fully described in Sections 3 and 4 of the Installation Restoration Data Management User's Guide. Additional geotechnical files are available but are not routinely used. The contract or task will specify additional files to be completed, if required.

6. The following lists, arranged by file, denote those items which the contractor shall acceptably enter and verify. Consult the DMS User's Guide for specific coding.

a. Map File (GMA).

(1) Installation.

(2) Site Type.

(3) Site Identification/Site Number.

(4) Coordinates and Coordinate System.

(5) Ground Surface Elevation.

(6) Source and Accuracy of Mapping Data.

(7) Aquifer.

(8) Pointer Information (cross reference for each boring and associated well(s)).

(9) Source of Data (company and individual).

b. Field Drilling File (GFD).

(1) Installation.

(2) Site Type.

(3) Site Identification.

(4) Depth to First Encountered Water.

(5) Depth to Bedrock.

(6) Depth to Deepest Part of Boring.

(7) Unified Soil Classification System Symbol (expanded for bedrock lithologies).

(8) Lithologic Intervals (by depth and thickness).

(9) Source of Data (company and individual).

(10) Dates.

c. Well Construction File (GWC). The abbreviations in parentheses which follow are the "Action Measurements," as explained in the User's Guide.

(1) Installation.

(2) Site Type.

(3) Site Identification.

(4) Stickup (STKUP).

(5) Bentonite Seal Interval (BSEAL).

(6) Blank Well Casing Interval (CASE).

(7) Well Casing Diameter (CASED).

(8) Length of Overburden Casing (CSEAL).

(9) Overburden Casing Diameter (CASES).

(10) Total Depth of Boring (DPTOT).

(11) Filter Pack Interval (GFILT).

(12) Grout Interval (GROUT).

(13) Screen Interval (SCREN).

(14) Dates.

(15) Source of Data (company and individual).

d. Groundwater Stabilized File (GGS).

(1) Installation.

(2) Site Type.

(3) Site Identification.

(4) Depth to Water (from ground surface).

(5) Date(s) Measured.

(6) Source of Data (company and individual).

7. Figures 11 to 15 are provided as examples of completed DMS coding sheets for each of the above files using the example boring log and well diagram (Figures 4 and 6, respectively). Additional data required for coding but not shown on Figures 4 or 6 follow:

a. Abbreviations:

GP = General AAP
PALEO = Code used for aquifer at General AAP.

b. Field Data:

(1) Surveyed coordinates for boring in UTM system are:

X : 54321 centimeters
and Y : 99876 centimeters.

(2) Surveyed ground surface elevation for boring is 4321 centimeters, using National Geodetic Vertical Datum of 1929.

(3) Well 87-14 is located in the same hole made by boring 87-14.

(4) Cement grout proportioned per these <u>Requirements</u> (cement:bentonite = 20:1).

(5) Well screen: 4" PVC, Schedule 40, .01 inch slot.

(6) Well installed 8 Nov 87.

(7) Water levels recorded by Mr. Smith after development were as follows:

Date	Depth from Top of Riser (ft)
12 Nov 87	9.0

20 Dec 87	9.7
04 Jan 88	11.4

K. Geotechnical Reports.

1. General. Requirements of the geotechnical report are discussed herein along with required guidelines for the technical writing style. When a separate geotechnical report is not required per contract, the elements herein shall be incorporated into the final contract/task report(s).

2. Report Contents. The geotechnical report shall contain as a minimum:

a. Title page.

b. Disclaimer.

c. DD Form 1473.

d. Abstract.

e. Table of Contents.

f. Background.

g. Regional Geology.

h. Site Geology.

i. Methodology.

j. Significant Conclusions.

k. Geotechnical Analysis.

l. Recommendations.

m. References.

n. Bibliography.

o. Appendices.

(1) Boring Logs.

(2) Well Diagrams.

(3) Well Development.

(4) Water Levels.

(5) Special Problems and Resolution.

(6) Aquifer Testing and Hydraulic Parameters.

(7) Geophysical Data.

(8) Vadose Zone Monitoring data.

(9) Physical Analyses.

(10) Topographic Survey Data.

p. Distribution List.

3. Content Details. Details of the above items are listed below:

a. Title Page. The title page contains the following:

(1) Title.

(2) Author(s).

(3) Company (prime contractor).

(4) Report Date.

(5) Report/Contract Number (provided by USATHAMA).

(6) Distribution Statement (statement indicating the agency authorized to release the report, provided by USATHAMA).

(7) Organization(s) for which report was prepared (typically a Department of the Army installation and USATHAMA).

(8) USATHAMA Address.

b. Disclaimer. The following "DISCLAIMER" shall immediately follow the title page:

<u>"DISCLAIMER"</u>

"The views, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision unless so designated by other documentation.

The use of trade names in this report does not constitute an official endorsement or approval of the use of such commercial products. This report may not be cited for purposes of advertisement."

c. Department of Defense (DD) Form 1473. This form shall be completed by the contractor. The data for blocks 1, 2, 3, 5, and 20 will be furnished by USATHAMA. A blank form is shown in Figure 9.

d. Abstract. The abstract is a summary of purpose, setting, and significant conclusions. This abstract should be more detailed than that given on the DD Form 1473.

e. Table of Contents. This item shall contain:

(1) Major Headings.

(2) Page Numbers.

(3) Figures, Tables, Plates (separately listed).

f. Background. Provide the objective of the geotechnical effort and a discussion of the contractor's corporate involvement within total survey.

g. Regional Geology. Include a discussion of the following topics for adjacent counties and states (as appropriate).

(1) Setting. Include maps and graphics for:

(a) Topography.

(b) Geomorphology.

(c) Physiography.

(d) Drainage.

(2) Stratigraphy. Include a complete, ideal sequence.

(3) Structure and Seismic Activity. Include cross sections.

(4) Hydrology. Include a discussion of surface and groundwater occurrences, drainage area, cross sections, and contour plots of potentiometric surfaces.

h. Site Geology. Discuss site specifics and how the site conforms and/or departs from the regional discussion based upon the knowledge gained from this study.

(1) Setting. Include local aspects of the regional setting.

(2) Stratigraphy. Discuss the sequence encountered.

(3) Structure and Seismic Activity. Include cross sections and local seismic history.

(4) Hydrology. Include hydrostratigraphic cross sections, contour plots, and a discussion of the relationship(s) between surface water and each aquifer encountered.

i. Methodology.

(1) Geotechnical Approach. Discuss literature and field considerations, provide boring and well placement rationale for each drilling site, note drilling locations on a detailed installation map and the largest scale U.S. Geological Survey topographic map depicting the installation.

(2) Drilling techniques. Specify the equipment, water source, procedures, and contractor.

(3) Borehole logging. Describe the procedures and specify the contractor.

(4) Well installation. Describe the materials (casing, screen, bentonite, cement, water, filter pack, etc. (see Table 1), construction procedures, and contractor.

(5) Well development. Specify the equipment, procedures, and contractor.

(6) Geophysical techniques. Provide the purpose, methods and equipment, selection rationale, method and procedural assumptions, limitations (theoretical and site-specific), resolution, accuracy, and contractor(s).

(7) Vadose Zone Monitoring. Provide the purpose, particular method(s) and equipment, selection rationale, method and procedural assumptions, limitations (theoretical and site-specific) and contractor(s).

(8) Topographic surveying. Specify the equipment, control systems, procedures, and contractor.

(9) Aquifer Tests. Specify the type of tests, literature reference, equipment, general procedure, and contractor.

(10) Physical Analyses. Provide the type of tests, literature references, and contractor.

j. Geotechnical Analysis.

(1) Provide indepth discussions of those geotechnical areas which were significant to the development of the report's conclusions. Describe any uncertainties or extrapolations of data and their relative importance to the conclusions drawn. Provide the data base, references, and actual calculations (in an appendix if over three pages) for quantitative discussions.

(2) Detail the integration of potential contaminant source locations, geologic, hydrologic, and available chemical data. Include how known or estimated groundwater velocities, directions, and chemical quality correspond to known or suspected up-, down-, and cross-gradient contaminant locations. For example, evaluate the occurrence of contaminants at a down-gradient well in terms of most likely up-gradient source, groundwater velocity and direction known or estimated in that area.

(3) Discuss each contaminant site in terms of the geologic, hydrologic, and (when available) chemical data generated by this study. Combine these individual site presentations into a total installation environmental discussion. Relate the installation environmental setting to the regional level. This site to regional development shall be done graphically with narratives to cover key and subtle points.

(4) Present and evaluate the results of any geophysical efforts in terms of design versus actual results, and actual results versus confirmatory/ground truth data; e.g., water levels, chemical analyses, borehole stratigraphy, etc.

(5) Discuss and evaluate the results of any vadose-zone monitoring.

(6) Specify and discuss any soil classifications and any other geotechnical data which were changed from the original field descriptions (see III.B.5.c.).

k. Significant Conclusions. Provide summary discussions of those project results which bear upon the intended survey objectives and related areas. Avoid quantitative conclusions based upon qualitative data. Highlight the limitations imposed upon the extrapolation of quantitative conclusions.

l. Recommendations. In addition to any specific recommendations requested within the Statement of Work, the contractor shall recommend those actions (if any) to refine or fill key data gaps and areas of uncertainty relative to the project objective. Additional recommendations should be made for those areas where a change in technique, methodology, or approach could result in a technical or cost benefit in any future efforts at the installation. The COR will specify whether the recommendations shall be included as part of the geotechnical or final report or be provided under a separate cover.

m. References. List by author, title, publication, volume, date, etc., those sources specifically referenced within the geotechnical report.

n. Bibliography. List as above those sources which provided or could provide general project-related data.

o. Appendices. Include data too bulky to be presented within the main body of the report; e.g., extensive tables or figures, or groups of data covering more than three pages. Where these data are in the DMS, they shall be presented in tabular and/or graphic form by the contractor directly from this System. The contractor shall coordinate with the COR to accomplish this requirement.

(1) Boring Logs. Provide legible copies of the "as submitted" field logs, uncorrected by office review and any lab analyses.

(2) Well Diagrams. Provide a detailed graphical presentation for each well with data per contract, to include hole depth, locations of screen, joints, centralizers, top of riser, top of protective casing, cave-in, granular filter pack, bentonite, grout, etc. Include an adjacent staff with appropriate Unified Soil Classification Symbols/rock classification for the entire length of drilled hole. Also graphically detail the protective measures at the well head; protective casing, pickets, caps, locks, etc. Key these sketches to both ground surface (depths below/heights above) and elevation (National Geodetic Vertical Datum of 1929).

(3) Well Development. Provide contractual data in tabular form.

(4) Water Levels. Provide, in tabular form, a listing of water levels (depths and elevations) for each well to include: well number, ground surface elevation, riser height above ground surface (stickup), riser elevation, first encountered water, initial 24-hour level after development, and subsequent static levels measured during the course of the contract. Each level must be annotated as to date of measurement and point from which measured. At least one complete set of static level measurements must be made and included for all project wells over a ten-hour period.

(5) Special Problems and Resolution. Discuss any special geotechnical problems and their resolution. This topic may be addressed in a separate letter to the COR.

(6) Aquifer Testing and Hydraulic Parameters. For the procedures and parameters required by contract, provide a detailed discussion of methodology used, assumptions made, and accuracy measured. Discuss how field conditions varied from those assumed in the method used. Evaluate the values measured against values reported in similar environments and against the setting and manner in which the values of this study were measured. Include references, field data, graphs of field data (e.g., time vs. drawdown plots), sample calculations for each parameter, and a graphical sketch of the relation between field and equation parameters. Present results in tabular form.

(7) Geophysical Data. Provide the data obtained during the study and any lengthy discussions better suited for an Appendix rather than in the main text.

(8) Vadose Zone Monitoring. Provide the data from any monitoring and any detailed discussions more appropriate for Appendices.

(9) Physical Analyses. Provide the references for all tests run. Include the method and procedures for any permeameter tests. Present the results in tabular form. Also, include grain-size graphs. Provide a discussion of these analyses with respect to permeability, both alone and as a comparison with aquifer test results.

(10) Topographic Survey Data. Provide a corrected, legible copy of the field topographic data; and in tabular form, the corrected coordinates and elevation of each surveyed and key feature, including, bores and wells, bench marks, key control points, etc. For each well, include the elevations of the top of the well riser, protective casing, and ground surface. See paragraph III.I. for more guidance. Provide a statement of closure, indicating the amount of error (in feet) to be expected for each set of coordinates and elevations.

p. Distribution List. This list will be provided by the Contracting Officer.

4. Technical Writing Style.

III.K.4.

a. Be quantitative. Use single, numerical values or ranges to convey magnitude, size, extent, etc. When ranges are used, denote the most probable value or a narrower, subrange of most probable occurrence. If qualitative terms must be used, define them within a numerical range.

b. Express confidence. Discuss the degree of confidence within the quantitative values generated. This confidence may be a function of field or lab conditions, technique, equipment, practice vs. theory, experience, personal bias, etc. Quantify the degree of confidence for key parameters such as elevations, velocities, permeabilities, porosities, gradients, etc. This shall be done through the use of (a) ranges with a most probable value, or (b) a single number with a plus-or-minus value attached.

c. For each point raised, provide a complete discussion. Do not leave the reader with unanswered questions which could have been naturally anticipated.

d. For maps, cross sections, boring staffs, well sketches, contour plots, etc., provide graphic scales (both vertical and horizontal) and a north arrow, as appropriate. Orient maps, contour plots, etc., with north toward the top of the page/sheet and orient the legend in the same manner as the map. Orient each graphic and its legend so that both can be easily read without rotating the graphic. Expand the graphics to cover the full paper size. Make all graphics fully and easily legible. Avoid any color coding on graphics. Provide vertical scales on both sides of each cross section and a horizontal scale along the base.

e. Adjust groundwater contours for topography (hills and valleys), streams (discharging, recharging), impermeable bedrock, and other obvious expressions of or alterations to the plotted groundwater contours.

f. Number all pages and denote those intentionally left blank.

g. Make sure separate graphics containing similar data agree. Make sure the field data, as corrected, agree with the graphical, tabular, and narrative presentations. Specify and discuss any changes made to the field data.

h. Address the four dimensional aspects of groundwater flow (X, Y, Z components and time) for each aquifer. The use of flow nets to supplement groundwater profiles and contours is desired.

i. Based on presurvey and survey data, provide hydrogeologic cross sections for the installation. These sections should include boring staffs with Unified Soil (and rock) Classification Symbols, summary well diagrams (with screen and seal locations noted), estimated stratigraphic correlation between borings, and estimated groundwater profiling.

j. <u>USE TABULAR FORMATS WHEREVER PRACTICAL</u>.

k. Provide literature/source credits for all data used or modified by the contractor. Credits shall appear in the text, on graphics, and in the list of references.

III.

L. Summary Lists.

1. Procedural and Material Summary. Table 2 denotes those geotechnical procedures and materials requiring specific USATHAMA-COR approval prior to their usage and the expected times for geotechnical evaluation and recommendations.

2. Document Submission Summary. In addition to those items to be submitted for approval per III.L.1., various documents and items discussed in these Geotechnical Requirements are to be submitted to the COR designated office (typically USATHAMA) after a particular action is completed. These materials and their submission times are summarized in Table 3.

M. FIGURES

BENTONITE APPROVAL REQUEST

Army Installation for Intended Use:

1. Bentonite Brand Name:

2. Bentonite Manufacturer:

3. Manufacturer's Address and Telephone Number:

4. Product Description (from package label or attach brochure):

5. Intended Use:

SUBMITTED BY:

Company:

Person:

Telephone:

Date:

USATHAMA APPROVAL/DISAPPROVAL: (check one)

Project Officer/Date: A D

Project Geologist/Date: A D

BENTONITE APPROVAL REQUEST

FIGURE 1

WATER APPROVAL REQUEST

Army Installation for Intended Use:

1. Water source:

   Owner:

   Address:

   Telephone Number:

2. Water tap location:

   Operator:

   Address:

3. Type of source:

   Aquifer:

   Well depth:

   Static water level from ground surface:

   Date measured:

4. Type of treatment prior to tap:

5. Type of access:

6. Cost per gallon charged by Owner/Operator:

WATER APPROVAL REQUEST

FIGURE 2

7. Attach results and dates of chemical analyses for past two years. Include name(s) and address(s) of analytical laboratory(s).

8. Attach results and dates of duplicate chemical analyses for project analytes by the laboratory certified by, or in the process of being certified by, USATHAMA for those analytes.

SUBMITTED BY:

Company:

Person:

Telephone Number:

Date:

USATHAMA APPROVAL/DISAPPROVAL:	(check one)	
Project Officer:	A	D
Project Geologist/Date:	A	D
Project Chemist/Date:	A	D

WATER APPROVAL REQUEST

FIGURE 2

GRANULAR FILTER PACK APPROVAL REQUEST

Army Installation for Intended Use:

1. Filter Material Brand Name:

2. Lithology:

3. Grain Size Distribution:

4. Source:

   Company that made product:

   Location of pit/quarry of origin:

5. Processing Method:

6. Slot Size of Intended Screen:

Submitted by:

Company:

Person:

Telephone:

Date:

USATHAMA APPROVAL/DISAPPROVAL:	(check one)	
Project Officer Name/Date:	A	D
Project Geologist Name/Date:	A	D

GRANULAR FILTER PACK APPROVAL REQUEST

FIGURE 3

BORING LOG GENERAL DATA

Project: GENERAL AAP   Boring: 87-14   Page: 1 of 3

Driller & Company: JACK JONES OF ACME Co

Geologist/Logger & Company: J. SMITH OF ACE Co   Signature: J Smith

Date Boring Started: 7 Nov 87   Completed: 8 Nov 87

Water Levels (from Ground Surface)   Drilling Rig: ABC 20

First Encountered: 7.0'   Date: 8 Nov 87

While Drilling: 7.0   Date: 8 Nov 87

At Boring Completion: Not Meas.   Date: 8 Nov 87

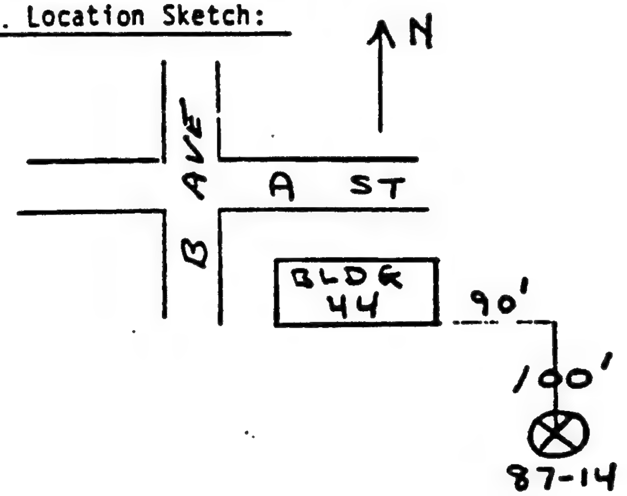
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
1987	Start	End	Start	End		Start	End	Start	End
7 Nov	1500	1700	0	5					
8 Nov	0800	1700	5	18.5					

Abbreviations:

Abbr	Meaning
3x3½, 2x2½	ID & OD OF SPL BBL SAMPLER
STD	1 3/8 x 2 STANDARD SAMPLER
R	RECOVERY
C/B	CORING INDUCED BREAK
NB	NATURAL BREAK
LC	LOST CORE
3x	3x3½ SAMPLER
2x	2x2½ SAMPLER

Location Sketch:



BORING LOG FORMAT

FIGURE 4

Project: GENERAL AAP	Boring: 87-14	Page: 2 of 3

Depth/ Elevation (FT)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		GROUND SURFACE	0		
0 – .8	OL	ORG CLAY, SANDY DK RED BRN 5YR 3/4 (MUNSELL) V MOIST, L PLAST ROOTMAT, TOPSOIL	S#1 .8	3x3½ 3	NOTES: 1. ALL SAMPLERS DRIVEN BY 140 LB HAMMER, FALLING 30" 2. ALL DEPTHS & RECOVERIES IN FT 3. DEPTHS FROM GROUND SURFACE
.8 – 4.6 1 2 3 4	SM	TRANSITIONAL .8–1.5 SILTY SAND 20% FINES F-M SAND < 60% F, 20% M MOIST, LOOSE YEL BRN 10YR 5/4 FAINTLY BEDDED FLAT LYING & X-BEDDED <5% SILTY CLAY (CL) LAMINAE FLUVIAL SHARP	1.5 S#2 3.0 3.5 S#3 4.6	2 R1.5 2x2½ 4 6 R1.5 STD 2 4 5 R1.5	NOTE 0' 1. DROVE 3x TO 1.5' 2. DROVE 2x TO 3.5' 3. DROVE STD TO 5' 4. SET HSA W/ PLUG TO 5', PULLED PLUG (HSA: 3¼" ID, 7" OD)
.6 5	SP	SAND <5% FINES F-C SAND { 60% C, 10% M, 25% F	5.0		END 7 NOV 87
6 7 8		V MOIST - SAT NO APPARENT BEDDING LOOSE LT RED BRN 5YR 6/4 V MOIST SAT FLUVIAL SHARP	S#4 6.0 6.5 S#5 7.5	3x 10 5 R1.0 2x 8 10	START 8 NOV NOTE 5' 1. HOLE DRY + OPEN TO 5' 2. DROVE 2x TO 6.5' 3. DROVE 2x TO 8.5' 4. FREE WATER ON SAMPLER & IN SAMPLE 5. MEAS. WATER AT 7.0 W/ ELEC TAPE. AFTER 5 MIN, STILL AT 7.0
9 10	GP	SANDY GRAVEL 20% F-C SAND 80% F GRAVEL LT RED BRN 5YR 6/4 MED DENSE SAT, N: APP BED FLUVIAL	8.5 S#6 9.8	R1.0 STD 2 4 8	6. DROVE STD TO 10' 7. SET HSA W/ PLUG TO 10', PULL PLUG

BORING LOG FORMAT

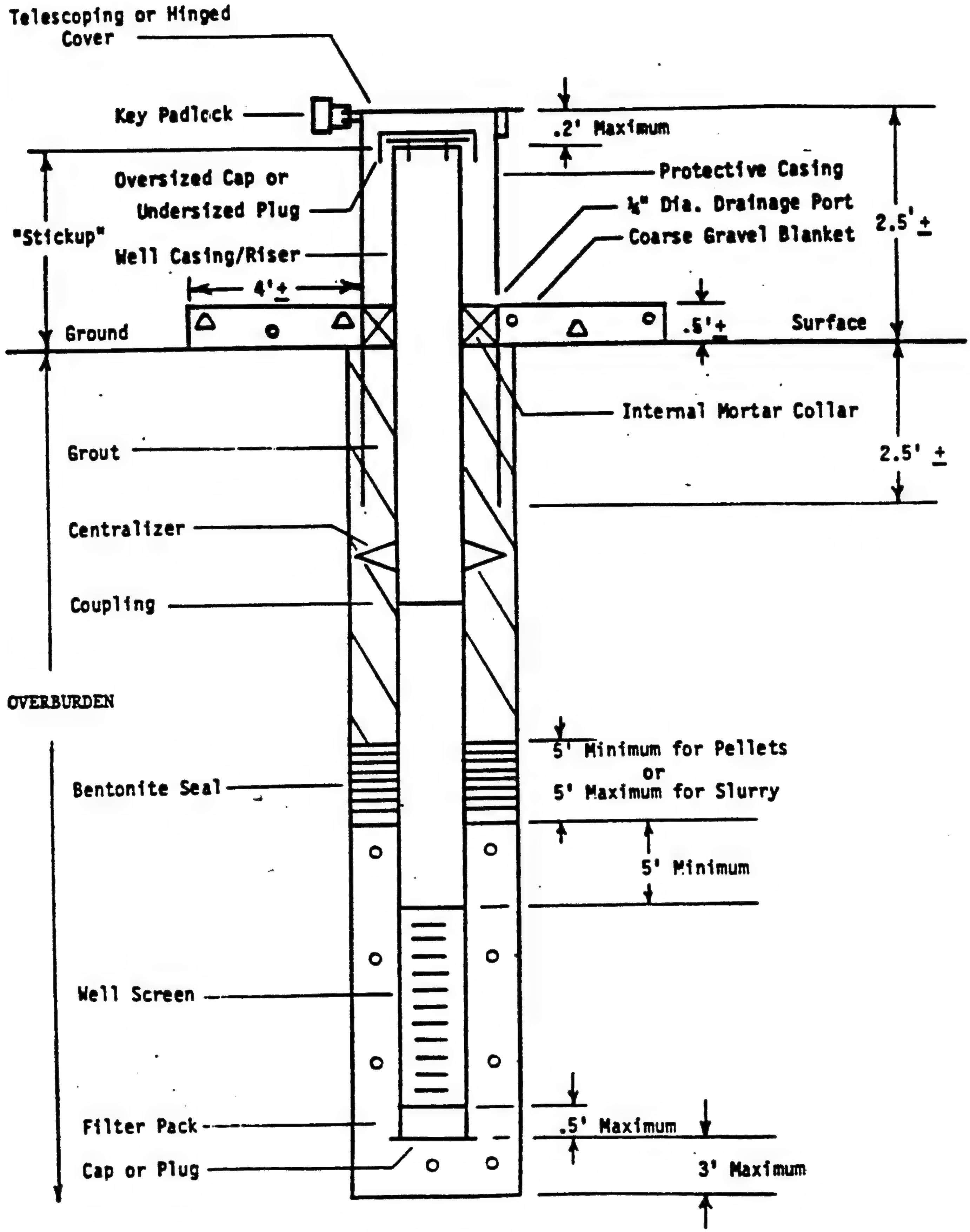
FIGURE 4

Project: GENERAL AAP	Boring: 87-14	Page: 3 of

Depth/ Elevation (FT)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
10	GP	SANDY GRAVEL (CONT'D)	S#7 10.5	37 100 R.5	NOTE 10' 1. DROVE 37 (REFUSAL)
		APPROXIMATE		10.9	
11 .9	L C	TOP OF WEATHERED ROCK LIMESTONE (LM) BASED ON CUTTINGS 1.1' LOST DUE TO DRILLING METHOD		12.0	2. PULLED AL SET 6" C TO 11.5' 3. DRILLED ROLLER BIT TO 12.0. LOSS 30 11.5'-12.
12	L C	LM, .5 LOST DUE TO WEATHERING & FRACTURES	12.5		
		TOP OF SL. WEAT. ROCK		RUN #1	NOTE 12
13	C1B	LIMESTONE SANDY (SILICEOUS) FOSSILIFEROUS, NUMEROUS CORALS &		R1.5	1. START CO RUN #1 AT
14	C1B	GASTROPODS THIN, HORIZONTAL BEDDING	BOX 1 OF 1	14.0	W/ 4" DOUB TUBE & DI BOT. DISC 2. RUN #1
15	NB	YEL BRN 10YR 5/4 HARD		RUN #2	40 GAL 12-12.
	NB	WELL CEMENTED			0 LOST
16	NB	DENSE - COARSE GRAINED SCAT (<5%) TIGHT 45° FRACTURES			12.5- SOUNDED 14.0 NOTE 14
17	C1B	NO STAINING SOLID, LOW PRIMARY & SECONDARY PERM. ST. GEORGE FM	18.0		1. RUN #2, COM WATER LOSS (50 GAL)., S NOTE 18.5 1. TOO FRACTU
18	L C	.5' LOST LM BADLY FRACTURED	18.5	R4.5 18.5	CORE, USE GE TO 30', 2. LOST 500 GA
.5		11.5' LOST, HIGHLY FRAC. LM (CUTTINGS) V. ROUGH DRILLING	S# 8		3. HOLE OPEN 4. SET WELL PULLED AL END 8 NO
30		BOTTOM OF HOLE 30.0			

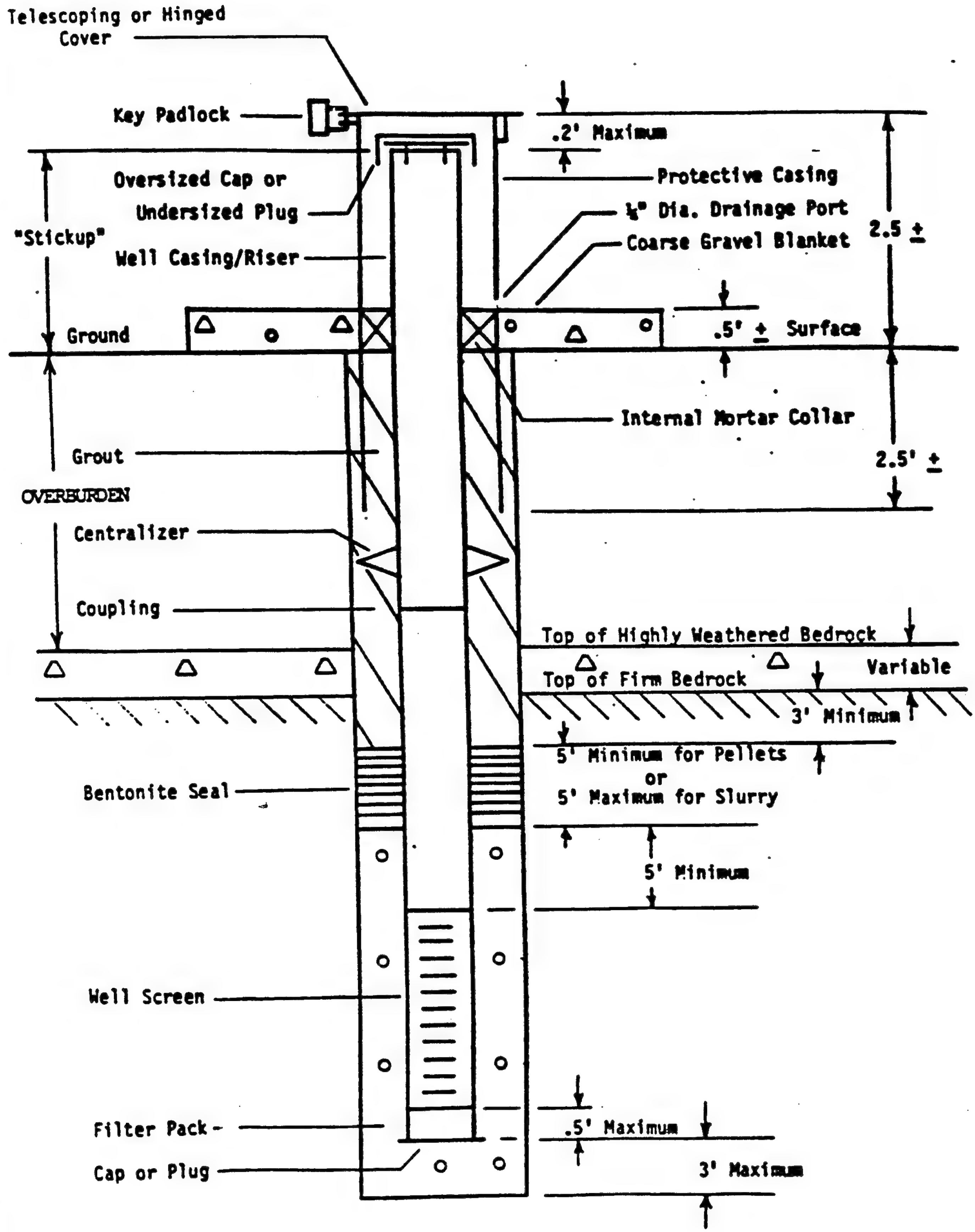
BORING LOG FORMAT

FIGURE 4

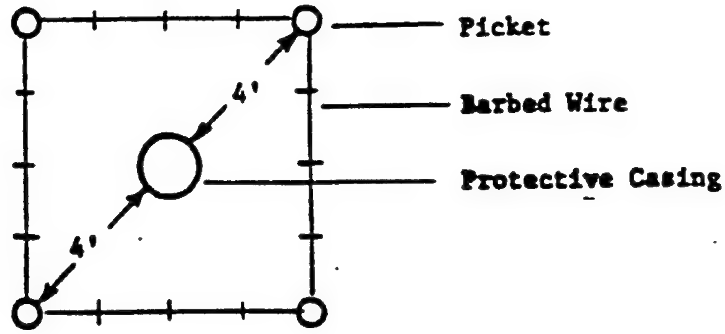


SCHEMATIC CONSTRUCTION OF
OVERBURDEN WELL

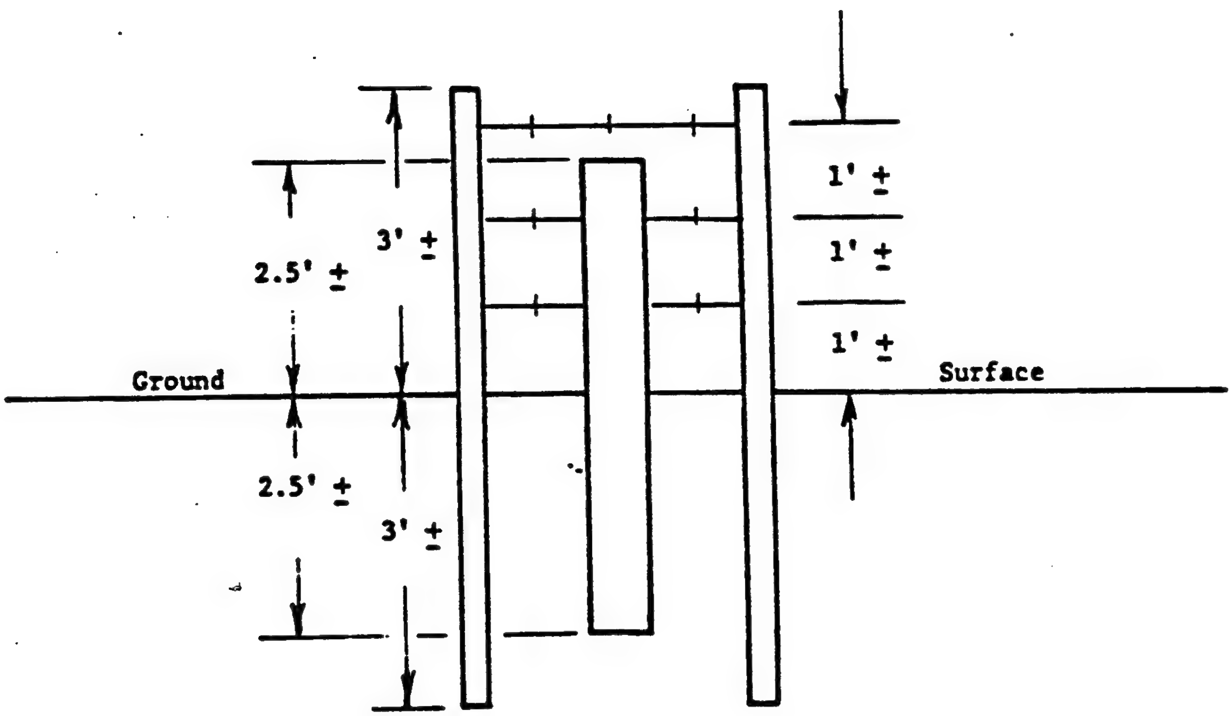
FIGURE 5



SCHEMATIC CONSTRUCTION OF
BEDROCK WELL

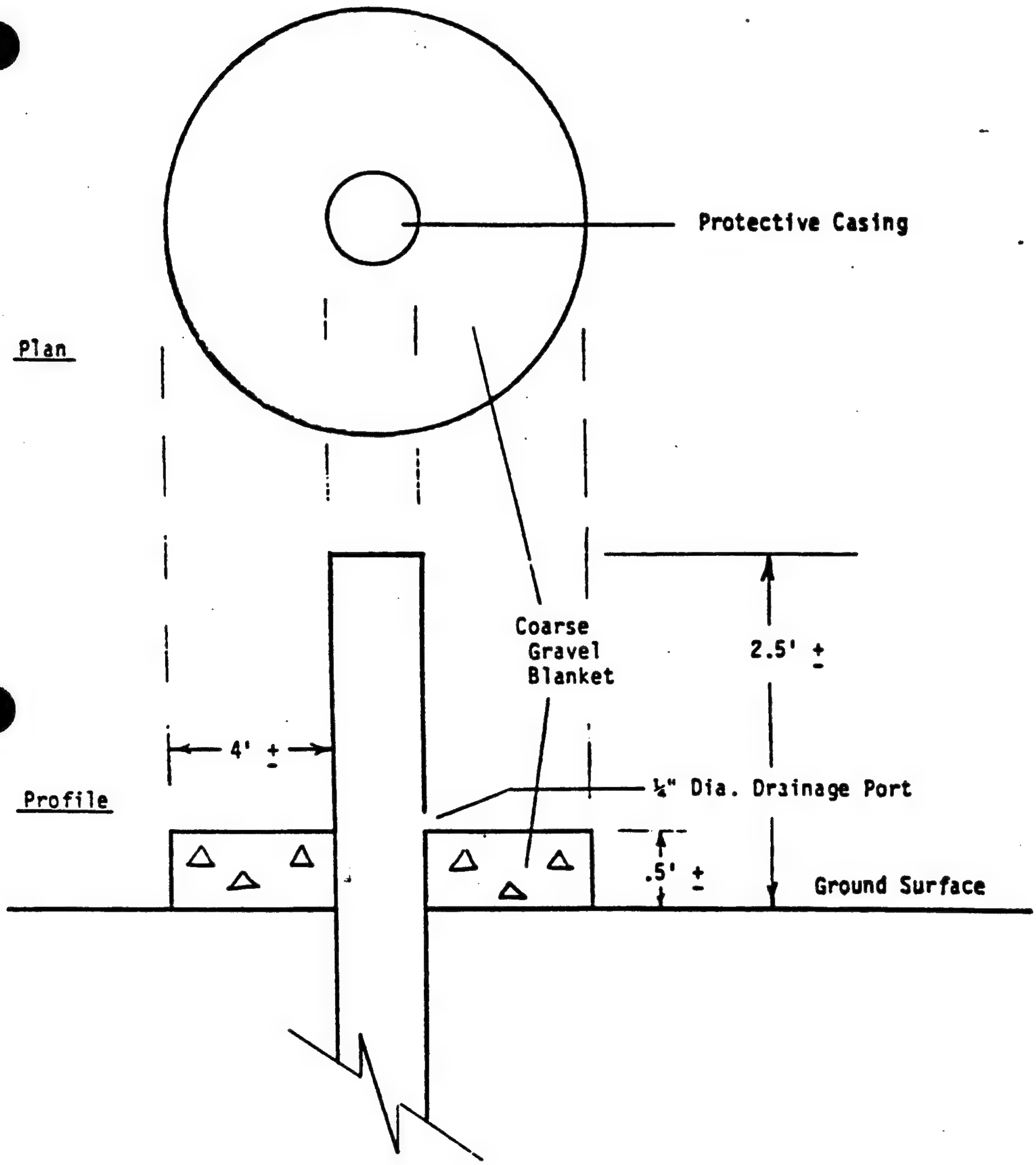


Plan



Profile

PICKET PLACEMENT AROUND WELLS
FIGURE 7



COARSE GRAVEL BLANKET LAYOUT

FIGURE 8

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a REPORT SECURITY CLASSIFICATION

1b. RESTRICTIVE MARKINGS

2a SECURITY CLASSIFICATION AUTHORITY

3 DISTRIBUTION/AVAILABILITY OF REPORT

2b DECLASSIFICATION/DOWNGRADING SCHEDULE

4 PERFORMING ORGANIZATION REPORT NUMBER(S)

5. MONITORING ORGANIZATION REPORT NUMBER(S)

6a NAME OF PERFORMING ORGANIZATION

6b OFFICE SYMBOL *(If applicable)*

7a. NAME OF MONITORING ORGANIZATION

6c. ADDRESS *(City, State, and ZIP Code)*

7b. ADDRESS *(City, State, and ZIP Code)*

8a NAME OF FUNDING/SPONSORING ORGANIZATION

8b. OFFICE SYMBOL *(If applicable)*

9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER

8c. ADDRESS *(City, State, and ZIP Code)*

10. SOURCE OF FUNDING NUMBERS

PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT ACCESSION NO.

11 TITLE *(Include Security Classification)*

12 PERSONAL AUTHOR(S)

13a. TYPE OF REPORT

13b. TIME COVERED FROM ________ TO ________

14 DATE OF REPORT *(Year, Month, Day)*

15. PAGE COUNT

16. SUPPLEMENTARY NOTATION

17 COSATI CODES

FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS *(Continue on reverse if necessary and identify by block number)*

19 ABSTRACT *(Continue on reverse if necessary and identify by block number)*

DD FORM 1473

FIGURE 9

Page 1 of 2

20 DISTRIBUTION/AVAILABILITY OF ABSTRACT

☐ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS

21. ABSTRACT SECURITY CLASSIFICATION

22a NAME OF RESPONSIBLE INDIVIDUAL

22b. TELEPHONE *(Include Area Code)*

22c. OFFICE SYMBOL

DD FORM 1473, 84 MAR

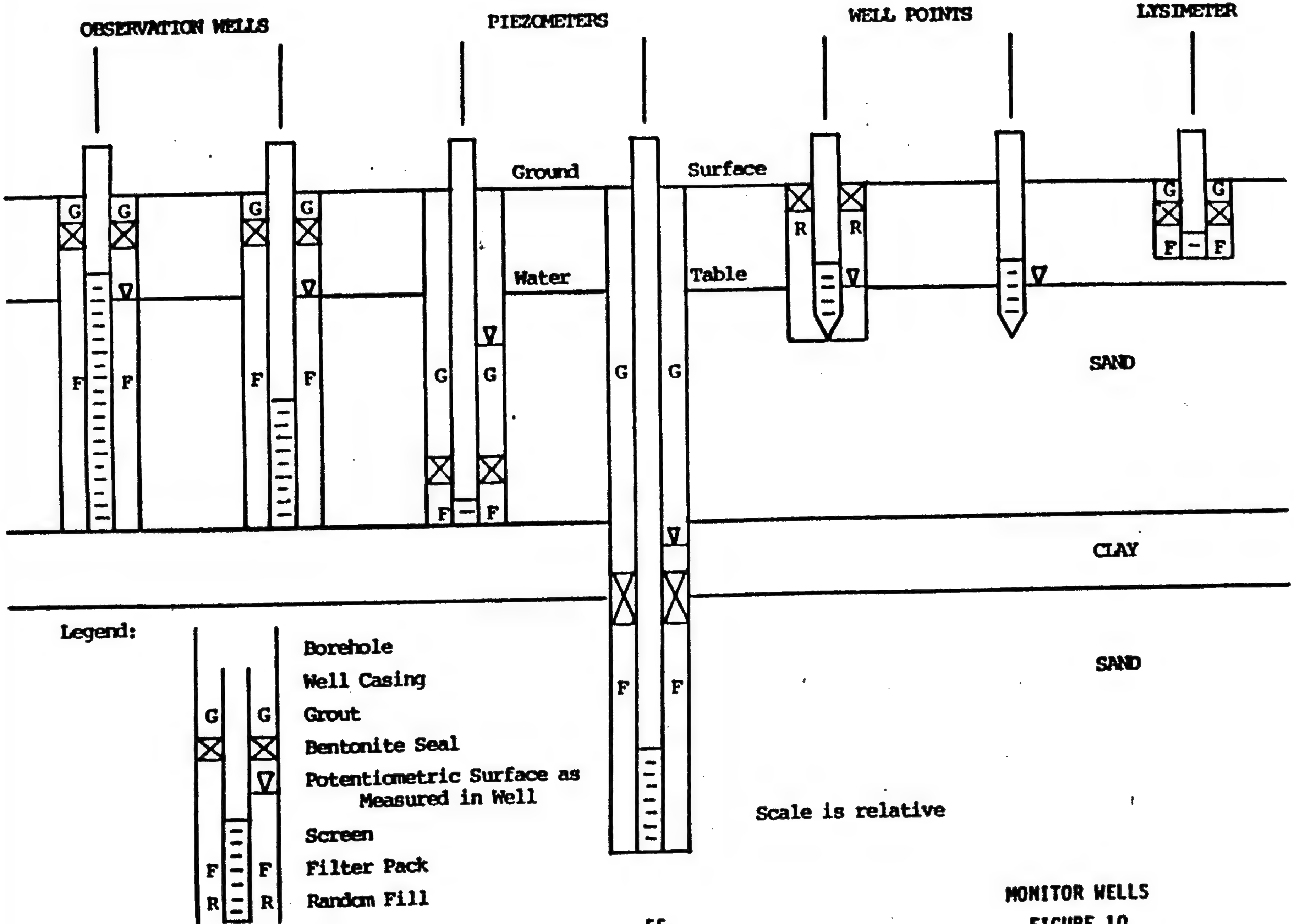
83 APR edition may be used until exhausted.
All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE

DD FORM 1473

FIGURE 9

Page 2 of 2



MONITOR WELLS
FIGURE 10

MAP CODING FORM

Installation GP Site Type BORE Site Id 87-14

Description Information :

Pointer Information:
Pointer Site Type: WELL Pointer Site Id: 87-14
Aquifer id: PALEO
Area Information:
Coord Sys: Acc Source Code: Exp: No.Points:

Coordinate	X	Y		X	Y
1			10		
2			11		
3			12		
4			13		
5			14		
6			15		
7			16		
8			17		
9			18		

LSMP Information:
Coordinate System: UTM Accuracy Source Code: S Exponent: Ø
Coordinate — X 54321 Y 99876

Elevation Information:
Elevation Source: S
Elevation Accuracy: Ø
Elevation: 4321

MAP FILE CODING SHEET (BORE)
FIGURE 11

MAP CODING FORM

Installation GP Site Type WELL Site Id 87-14

Description Information :

Pointer Information:
Pointer Site Type: BORE Pointer Site Id: 87-14
Aquifer Id: PALEO
Area Information:
Coord Sys: Acc Source Code: Exp: No.Points:

Coordinate	X	Y		X	Y
1			10		
2			11		
3			12		
4			13		
5			14		
6			15		
7			16		
8			17		
9			18		

LSMP Information:
Coordinate System: UTM Accuracy Source Code: S Exponent: Ø
Coordinate — X 54321 Y 99876

Elevation Information:
Elevation Source: S
Elevation Accuracy: Ø
Elevation: 4321

MAP FILE CODING SHEET (WELL)

FIGURE 12

GEOTECHNICAL DATA ENTRY CODING FORM

INST	FILE TYPE	LAB	INITIALS
GP	GFD	AC	JS

FIELD DRILLING AND WELL CONSTRUCTION

SITE TYPE	SITE ID
BORE	87-14

DATE	ACTION MEAS	METHOD	DEPTH	INTERVAL	VALUE	UNITS	ENTRY
11/08/87	GRDWT	01			7.0	FT	
11/08/87	DBRK	01			11.9	FT	
11/08/87	DPTOT	01			30.0	FT	
11/07/87	USCS	01	0.0	.8		FT	OL
11/07/87	USCS	01	0.8	3.8		FT	SM
11/08/87	USCS	01	4.6	3.4		FT	SP
11/08/87	USCS	01	8.0	3.9		FT	GP
11/08/87	USCS	01	11.9	18.1		FT	LMSN
/ /							

FIELD DRILLING FILE CODING SHEET

FIGURE 13

INST	FILE TYPE	LAB	INITIALS
GP	GWC	AC	JS

GEOTECHNICAL DATA ENTRY CODING FORM

FIELD DRILLING AND WELL CONSTRUCTION

SITE TYPE	SITE ID
WELL	87-14

DATE	ACTION MEAS	METHOD	DEPTH	INTERVAL	VALUE	UNITS	ENTRY
11/08/87	STKUP	01			2.3	FT	
11/08/87	BSEAL	01			5.0	FT	
/ /	CASE	01			25.0	FT	
/ /	CASED	01			.33	FT	
/ /	DPTOT	01			30.0	FT	
/ /	GFILT	01			10.0	FT	
/ /	GROUT	04			15.0	FT	
/ /	SCREN	02			5.0	FT	
/ /							

WELL CONSTRUCTION FILE
CODING SHEET
FIGURE 14

GEOTECHNICAL DATA ENTRY CODING FORM

INST	FILE TYPE	LAB	INITIALS
GP	GGS	AC	JS

UNITS
FT

GROUND WATER STABILIZED *

SITE TYPE	SITE ID	DATE	DEPTH
WELL	87-14	11/12/87	6.7
WELL	87-14	12/2Ø/87	7.4
WELL	87-14	Ø1/Ø4/88	9.1
		/ /	
		/ /	
		/ /	
		/ /	
		/ /	
		/ /	
		/ /	
		/ /	
		/ /	

* - Depth measured from ground surface

GROUNDWATER STABILIZED FILE CODING SHEET

FIGURE 15

N. TABLES

TABLE 1

WELL CONSTRUCTION MATERIALS

Material (Example Entries)	Brand/Description (Example Entries)	Source/Supplier (Example Entries)
PVC Casing	4.0" ID, Schedule 40, flush threaded; 2" ID, Schedule 40, flush threaded.	ABC Mfg; Aville, Minnesota
PVC Screen	.05" slot, 4.0" ID, Schedule 40, flush threaded, .02" slot, 2" ID, Schedule 40, flush threaded	ABC Mfg; Aville, Minnesota
Bentonite (drilling fluid and grout)	Tru-gel	A. O. Bentonite, Bville, Wyoming
Granular Bentonite (seal)	Gran-Bent	White Mud, Cville, Montana
Bentonite Pellets (seal)	(No brand name available)	PELBENT, Dville, Utah
Sand (filter pack)	8-12 silica sand	State Sand, Mville, Colorado; supplier: EFG Co. Eville, Utah
Cement (grout)	Portland Type II	A. Lumber Co., Eville, Utah
Drilling Water	St. Peter Sandstone	Production Well #1, Tap at well house General AAP
Drilling Rod Lubricant	Slick Turn	Oil Products Co., Fville, Texas
Air Compressor Oil	Oil #40	Oil Products Co., Fville, Texas

TABLE 2

PROCEDURAL AND MATERIAL APPROVAL SUMMARY

Items Requiring Approval	Reference Section	Time for Approval	Turn Around Time for Geotechnical Evaluation and Recommendation
Drilling Method	III.A.1.c.	Prior to contract/task award	During Proposal/ Bid Evaluation
Air Usage	III.A.2.	Prior to contract/task award	During Proposal/ Bid Evaluation
Bentonite	III.A.10.a.	Prior to drilling equipment arrival onsite	6 Working Days
Water	III.A.10.b.	Prior to drilling equipment arrival onsite	3 Calendar Weeks
Abandonment	III.A.11.	Prior to casing removal or backfilling	4 Consecutive Hours
Borehole Fluids, Cuttings, and Well Water Disposal	III.A.16.	Prior to technical plan acceptance	During Plan Evaluation
Time of Well Installation	III.C.1.	Prior to drilling	3 Working Days
Well Screen and Casing Materials	III.C.2.a.	Prior to contract/task award	During Proposal/ Bid Evaluation
Granular Filter Pack	III.C.5.a.	Prior to drilling	8 Working Hours
Protective Casing, Exceptions	III.C.8.a	Prior to drilling	6 Working Days
Geophysical Procedures	III.G.	Prior to use	Time not specified
Vadose Zone Monitoring	III.H.	Prior to use	Time not specified

LE 3

CONTRACTOR DOCUMENT/ITEM SUBMISSION SUMMARY

Document/Item	Reference Section	Submission Time	Submission To
Geotechnical Requirements (modified per contract)	II.A.	With Technical Plan (or equivalent document)	USATHAMA-COR
Licenses of Surveyor and Driller	III.A.5.	With Technical Plan (or equivelent document)	USATHAMA-COR
Submissions to State and/or local authorities	III.A.5.	As required	State and/or local offices coordinated through USATHAMA
Abandonment memorandum (written)	III.A.11.	Within 5 working days of telephonic request	Contracting Officer through USATHAMA
Abandoned boring and/or well record	III.A.11.	Within 3 working days of abandonment	USATHAMA-COR
Soil physical testing results	III.A.12.d.	Within 10 working days of final test	USATHAMA-COR
Rock core photography	III.A.13.	Within 2 weeks of last coring	USATHAMA-COR
Boring logs	III.B.2.	Within 3 working days after boring completion or instrumentation completely installed	USATHAMA-COR
Boring log abbreviations, general legend	III.B.5.v.	With first or last log, as appropriate	USATHAMA-COR
Two keys to padlocks	III.C.8.c.(8)	Upon completion of last well placement	Installation Representative and USATHAMA
Well diagram	III.C.12.c.	Within 3 working days of well/protective measure completion	USATHAMA-COR

TABLE 3 (Cont'd)

Document/Item	Reference Section	Submission Time	Submission To
Well development record	III.D.2.	Within 3 working days after development	USATHAMA-COR
Well development water sample	III.D.10.	Within 3 working days after developing that well	USATHAMA-designated individual
Geotechnical Report(s)	III.K.	As required per contract or task	Contracting Officer through USATHAMA